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Empire Challenge 2010 Spiral Test of L-3 Communication's Net-Tactical Communication System

and

Follow-on JBAIIC Experimentation and Participation in Empire Challenge 2010 (EC10)

by

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JBAIIC conducted technical testing of the L-3 Communications Corporation (L-3) Net-Tactical (Net-T) system and the EchoStorm Worldwide LLC developmental U.S. Army Data Archive and Retrieval (DAR) system during the week of July 19, 2010 at Fort Huachuca, Sierra Vista, Arizona. Testing was sponsored by Headquarters Air Force (HAF) Intelligence, Surveillance, and Reconnaissance Innovations office (HAF/A2Q), and served as a spiral development event for Empire Challenge 2010 (EC10), which immediately followed from July 26 to August 12, also at Fort Huachuca.

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and

Follow-on JBAIIC Experimentation / Participation in Empire Challenge 2010 (EC10)

Executive Summary

Net-Tactical Communication System

JBAIIC conducted technical testing of the L-3 Communications Corporation (hereafter referred to as L-3) Net-Tactical (Net-T) system and the EchoStorm Worldwide LLC developmental U.S. Army Data Archive and Retrieval (DAR) system during the week of July 19, 2010 at Fort Huachuca, Sierra Vista, Arizona. This testing was sponsored by Headquarters Air Force (HAF) Intelligence, Surveillance, and Reconnaissance Innovations office (HAF/A2Q), and served as a spiral development event for Empire Challenge 2010 (EC10), which immediately followed from July 26 to August 12, also at Fort Huachuca.

The following are the principal findings for Net-T testing:

- The Net-T architecture supported the distribution of the JBAIIC Common Information/Tactical Picture (CIP/CTP) to tactical users including four ROVER/GoBook operators and bidirectional chat and VoIP between all tactical units (four ROVERs and the L-3 aircraft) and the Tactical Operations Center (TOC).
- For the routes flown by the L-3 aircraft (typically a 12 minute orbit), connectivity between the ROVERs and TOC was not reliable because of the range limitations of the antenna built into the ROVER and aircraft orientation (loss of connectivity in turns). The external Ku band (downlink) antenna used by some ROVERs (R4 and R1) improved downlink connectivity.
- The communications link from the TOC to the aircraft was reliable with connectivity estimated at more than 90 percent.
- The observed downlink throughput from Vortex to ROVER was generally significantly less than the expected value.
- The rack-mounted DAR (RDAR) successfully received and archived high definition full motion video (FMV) from the L-3 MX-15iHD sensor and successfully disseminated transcoded L-3 MX-15iHD-sourced FMV to a tactical user (R2) over Net-T.
- A tactical user (R2) was unable to access the RDAR archive via Net-T due to unreliable connectivity.

- RDAR produced Cursor on Target (CoT) formatted messages that provided L-3 aircraft Precise Participant Locations and Identification (PPLI) and MX-15iHD sensor points of interest (SPOI) to the JBAIIC CIP/CTP via the NOC CoT server.
- L-3 sensor SPOI CoT messages were successfully converted to VMF and displayed on FBCB2 clients.

Empire Challenge 2010 (EC-10)

The objective in Empire Challenge experimentation was generally to demonstrate data exchanges and collaboration; not to create realistic free-play scenarios. Nine-line targeting messages were developed by the Joint Reconfigurable Vehicle (JRV) clients and SNC tactical wireless handheld computers (Tacticomp T5s) and transmitted on both the LOS PRC-117G (CFE) net and the L-3 communications airborne relay (KSAF) to the NOC for dissemination to strike aircraft.

The principal findings for JBAIIC in EC-10 were:

- TOC to JRV communications over the L-3 communications link were often unreliable, due primarily to the limited Vortex-ROVER range and Fort Huachuca air operations restrictions precluding moving the L-3 aircraft to orbits that would optimize the communications link.
- DCAS messages were received and acknowledged by the F-16C strike aircraft. The messages received were J3.5 and J12 messages but the aircraft did not receive complete digital nine-line information. A digital standard for the nine-line brief and the on-station reports issued by aircraft has not yet been implemented by the U.S. Military.
- MITRE developed code so that the track number automatically assigned in the NOC was passed to the JTAC. Thus, both pilot and JTAC could refer to a given target with the same track number. This improved the efficiency of CAS operations.
- The JBAIIC NOC created and disseminated CIP/CTPs for the UCSN, KSAF, and CFE security domains. The information available in each of those domains is indicated in Table 4. The KSAF and CFE CIP/CTP were available to tactical users in the JRV on both JRV clients and the SNC T5 devices. Other tactical users equipped with ROVERs accessed the KSAF CIP/CTP on GoBooks.
- The RDAR successfully transmitted transcoded FMV to tactical users in the JRV. The imagery was displayed on the JRV clients and the SNC T5 devices. FMV imagery from the Predator surrogate, BETSS-C, and Constant Hawk were disseminated over the L-3 KSAF communications link. Tactical users were not able to retrieve imagery from the RDAR repository because the link was not sufficiently stable.
- Throughout EC10, there were problems with multicast on the KSAF network. The effect was to limit access to various FMV streams. The multicast restrictions severely affected RDAR operations and limited its utility in EC10.

- FBCB2 successfully displayed the PPLI, SPOI and FOV of a variety of sensors. F-16C PPLI were displayed on FBCB2 but the aircraft did not send their sensor/targeting pod SPOI, precluding its display.
- The TOC was able to access FMV from a variety of sources by a variety of means. Sources included: Predator surrogate, ScanEagle, BETSS-C, Constant Hawk, PGSS, Cortez, Canadian aerostat, Green Devil, and Cerberus. Means of access included direct access, Valiant Angel, and RDAR. HSG and multicast issues constrained multi-domain distribution of FMV.
- The TOC received AOCO tracks and injected those tracks into the CFE CIP/CTP. These tracks were investigated with the Predator surrogate sensors and, in at least one instance, the target was passed to F-16C strike aircraft.
- The JBAIIC TOC was not able to employ CDCIE chat and therefore could not access the primary EC10 collaboration tool. The TOC systems need to be configured so that they are compatible with CDCIE.

1.0 Network-Tactical (Net-T) Testing

JBAIIC conducted technical testing of the L-3 Communications Corporation (hereafter referred to as L-3) Network-Tactical (Net-T) system and the EchoStorm Worldwide LLC developmental U.S. Army Data Archive and Retrieval (DAR) system during the week of July 19, 2010 at Fort Huachuca, Sierra Vista, Arizona. This testing was sponsored by Headquarters Air Force (HAF) Intelligence, Surveillance, and Reconnaissance Innovations office (HAF/A2Q), and served as a spiral development event for Empire Challenge 2010 (EC10), which immediately followed from July 26 to August 12, also at Fort Huachuca. [1]

1.1. Venue

During the interval July 20-23, Net-T technical testing was conducted at Fort Huachuca in Sierra Vista, AZ. Testing locations on Ft Huachuca included: the Intelligence Systems Integration Laboratory (ISIL) parking lot, Libby Army Airfield, and Garden Canyon Road as far west as Training Area Papa on Ft Huachuca's South Range.

[1] Although Net-T was not used during EC10, germane L-3 hardware and software, and DAR were. As a result, additional information and data relevant to achieving Net-T and DAR objectives were collected during EC10. Therefore, assessment of objectives is not discussed separately for the Net-T and EC10 sections, but is addressed collectively in Section 3 of this document.

1.2. Testing Schedule

The Net-T testing centered on flights of the L-3 Cessna 208 "Predator surrogate" aircraft. It was scheduled to fly for four hours on each of July 21, 22, and 23. The scheduled flight times on all three days were affected by weather. The actual flight hours are shown in Table 1.

Table 1. Net-T Testing Flight Schedule

Day	Take off (local)	Landing (local)	Operational flight time (hr)	Comments
July 21	8:30	8:50	0	Flight aborted due to near encroachment of aerostat air space. Unable to resume mission due to weather.
July 22	7:55	11:15	3.3	Take off time moved up to allow for weather.
July 23	7:10	9:37	2.5	Take off time moved up to allow for weather. Flight aborted due to weather.

Testing consisted primarily of: Voice over Internet Protocol (VoIP), chat, and Common Intelligence Picture /Common Tactical Picture (CIP/CTP) communication checks with each Remotely Operated Video Enhanced Receiver (ROVER) by the JBAIIC Battalion (BN) Tactical Operations Center (TOC) and throughput tests. The test plan for July 23 is provided in Appendix 1.

1.3.1. Net-T Architecture

Net-T is an Internet Protocol (IP)-based, full-duplex, wideband wireless communication architecture. At Fort Huachuca, the Net-T was operated UNCLASSIFIED and included the hardware components delineated below:

On the ground vehicles:

- L-3 ROVER 5 (four). The individual ROVERs were referred to as R1, R2, R3, and R4. The locations were: R4 on the Joint Reconfigurable Vehicle (JRV)[2], R1 on the JBAIIC Dodge Ram utility pick-up truck, R2 and R3 on a Jeep SUV rental vehicle.

- GoBook notebook computers (connected to each of the ROVERs).

[2] The JRV is an extensively modified Hummer H2 with state-of-the-art networking and tactical communications equipment, which serves as a mobile test bed for the receipt, integration, and transmission of tactical ISR and combat data to both mounted and dismounted warfighters.

- Two external omni-directional ROVER Ku band downlink antennas; one mounted on top of the JRV (R4), and one (July 23 only) attached to R1 in the cab of the Dodge Ram pick-up.

On the L-3 Cessna 208 aircraft (Predator surrogate):

- L-3 Vortex multi-use transceiver (ROVER transmission and reception).
- Air Terminal Equipment (ATE) laptop computer.
- Tactical Digital Video Recorder (TDVR) laptop computer.
- Mini Tactical Common Data Link (TCDL) for Ground Control Station (GCS) transmission and reception.
- High definition (HD) video encoder.
- MX-15iHD Sensor (E/O and IR)

ISIL rooftop:

- Directional tracking antenna (9.5")
- Mini TCDL (for aircraft transmission and reception).

In the BN TOC:

- Surface Terminal Equipment (STE) laptop computer.
- TDVR laptop computer.

In the ISIL

- TDVR laptop computer.

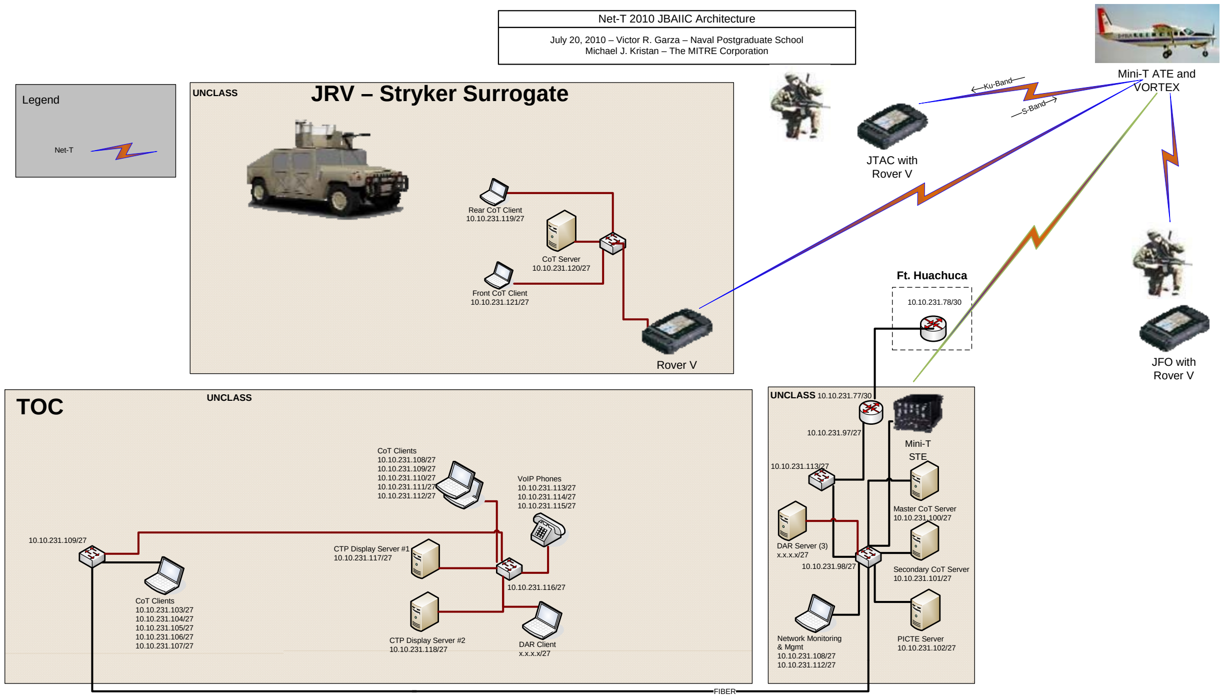

Figure 1. Network Architecture for Net-T Testing

Note: *Figure 1 is a schematic of the network architecture used for Net-T testing. This figure is shown at higher resolution in Appendix 7.*

1.4. Antennas

The ROVER 5 has built-in antennas. The antennas are nominally omni-directional but have a preferred direction of higher sensitivity. An operator could improve the Vortex to ROVER range by manually pointing the ROVER toward the L-3 aircraft position.

The ROVER 5 on the JRV (R4) was, from the start of testing, equipped with a Ku frequency band downlink antenna. This antenna was used only for receipt of Vortex to ROVER communications and was mounted on top of the JRV because the ROVER's internal antennas would have been obstructed from inside the vehicle. In the JRV, the ROVER internal antenna was used exclusively for ROVER to Vortex communications.

The other three ROVERs used only their internal antennas for both uplink and downlink, except for R1, which added a Ku band downlink antenna on July 23. The downlink antennas provided an effective range superior to the internal ROVER antennas.

The directional antenna for TOC to Vortex communications was located on the roof of the ISIL. It tracked the aircraft using the GPS position metadata inherent in the down-linked data.

1.5. L-3 Communications Range

The effective range of the TOC to ROVER Net-T-supported bidirectional communications was a function of, at least, the variables listed below:

- The effective range of TOC Ground Control Station (GCS) to aircraft communications.
- The effective range of ROVER to Vortex communications (a function of the antennas and their orientation).
- Aircraft altitude.
- Aircraft orientation.

1.5.1. Aircraft to TOC Communications Range

The TOC to aircraft (Vortex) communications range for the configuration used in this testing was 10-11 statute miles. L-3 TOC personnel estimated the aircraft to TOC link was good at least 90 percent of the time. Loss of link was believed to be primarily due to aircraft maneuvers with possibly a small portion due to exceeding the range limit. Longer ranges may be obtained by using a different configuration of antennas and amplifiers.[3]

The aircraft flew a predefined orbit. The precise route was dictated by flight restrictions, the need to maintain a maximum range of approximately 10 miles between the aircraft and the directional antenna on the roof of the ISIL, and the planned area for the day's scenario ground operations. The aircraft normally flew at 10,000 feet above Mean Sea Level (MSL). On July 23 it was forced to fly at 8,000 feet MSL due to low cloud cover. The elevation of Fort Huachuca's Libby Army Airfield is 4,719 feet.

1.5.2. ROVER to Vortex Communications Range

During the experiment, one real-time range measurement was made from the JRV of the ROVER to Vortex range. The range between the JRV and the aircraft was measured on the JRV CIP/CTP display when the link with the aircraft was lost. The range was observed to be slightly more than seven statute miles. Since the JRV was equipped with the Ku band downlink antenna, this range would be greater than for a ROVER operating only on its internal antenna. The nominal range for ROVER 5 to Vortex communications using the internal ROVER antenna is approximately four miles.

[3] Both Vortex/ROVER transceiver power, and aircraft antenna configuration and maneuvers, probably contributed to the operationally limited ranges observed in EC10.

The ROVER operators often reported communications breaks due to both excessive ROVER-Vortex range and aircraft maneuvers. The ROVER operators frequently manually tracked the aircraft with the ROVER to improve the range of communications. One ROVER operator remarked that he used the CIP/CTP as an indication of the direction in which he should point the ROVER to improve communication continuity.

1.6. Data Throughput Across the ROVER to Vortex Link

Two tests of the throughput of the ROVER to Vortex links (uplink) were attempted. On July 22 throughput was measured successively with: R1; R1 and R2; and R1, R2, and R3 with R4 energized. These data are listed in Appendix 2. On July 23 a second test was conducted. This run was aborted due to weather and, as a result, all operational ROVERs were turned on for the full duration of the test. The results of this test are listed in Appendix 3. Video transmission (downlink) was turned off for these measurements. For the July 22 test, the results for R3 were anomalously low and on July 23, R3 did/could not transmit, so R3 data were not included in Table 2. below.

Nominal throughput for the Vortex to ROVER link is 10.7 megabits per sec (Mbps). For ROVER to Vortex maximum uplink throughput is 5 Mbps. But with the error checking implemented in this testing, the effective maximum uplink rate was expected to be approximately 4 Mbps.

Table 2. Observed ROVER to Vortex (Uplink) Throughput

Date	ROVER	Average throughput (Kilobits/sec)	Number of observations averaged	Max throughput value (Kilobits/sec)
7/22	R1	2317	6	5478
7/22	R2	1695	8	3727
7/22	R4	873	3	1184
7/23	R1	1309	32	4560
7/23	R2	1258	6	2240
7/23	R4	751	36	1600

Most of the time the ROVERs showed throughput far below the expected maximum value, although the maximum throughput observed for R1 on both July 22 and July 23 met or exceeded the expected maximum. On both days, R1 showed the highest throughput and R4 showed the lowest throughput.

On July 22 the throughput reported were averages over intervals (see Appendix 2). It is possible that these intervals contained periods of no connectivity, thus lowering the throughput. The throughput reported on July 23 were instantaneous and would not be so affected.

An observer reported that on July 22 the JRV ROVER (R4) did not have a Vortex link about 50 percent of the time due to the aircraft orbit. On July 23 the R2 operator reported connectivity was about 50 percent.

Throughput was measured on July 23 by using File Transfer Protocol (FTP) to transfer files from the Network Operations Center (NOC) (located adjacent to the TOC) to the ROVERs. The ROVERs used WinSCP, an open source freeware FTP client for Windows. The R1 operator reported frequent WinSCP crashes.

1.7. Ground Control Station (GCS)

The L-3 GCS in the TOC received both electro-optical (E/O) and infrared (IR) Full Motion Video (FMV) imagery simultaneously from the MX-15iHD sensor mounted in the L-3 Cessna aircraft. The GCS workstation displayed the real-time track of the aircraft on a Google Earth map (see Figure 2). The GCS station had software for remote control of the aircraft sensor. This sensor control software was not loaded on any of the ROVER/GoBook nodes.

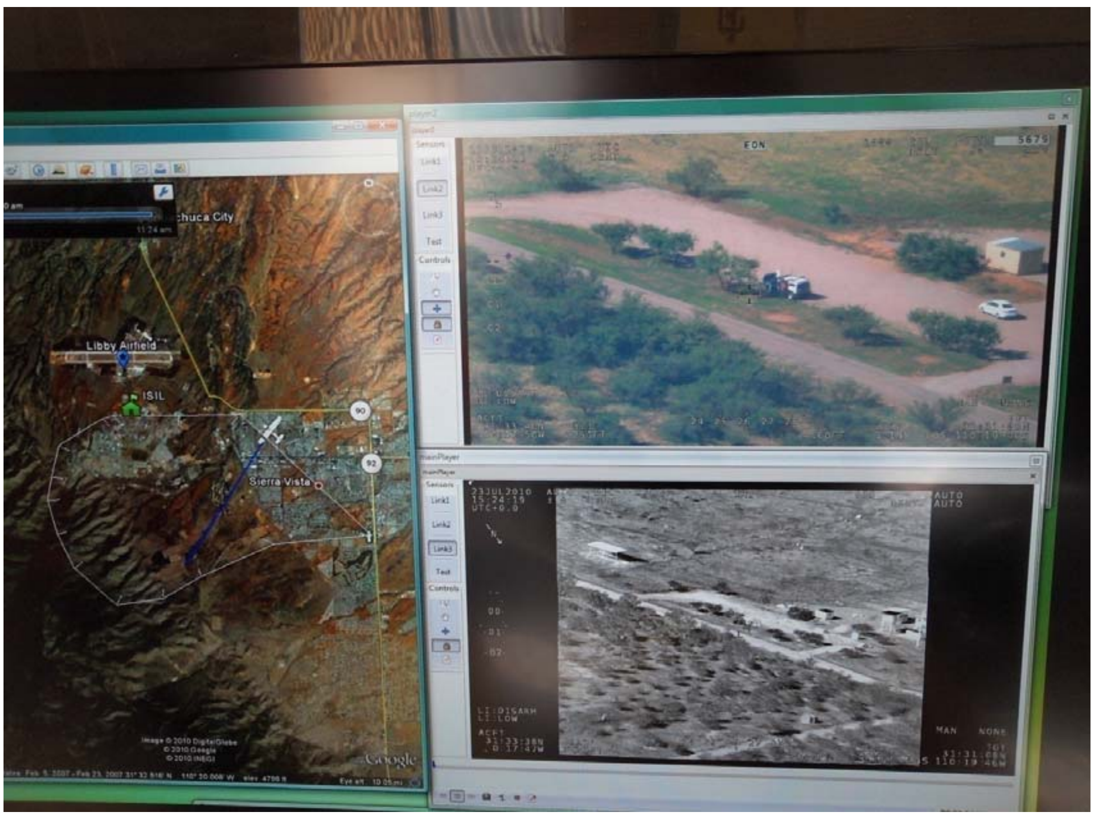

Figure 2. Snapshot of the L-3 Communications GCS Display in the TOC on 23 July 2010

Note: *The image on the left of the screen shows the L-3 aircraft orbit with an icon indicating aircraft position and a blue line showing the sensor point of interest. The image at the upper right is from the MX-15iHD E/O camera focused on the JRV parked just off Garden Canyon Road. The lower right image is from the MX-15iHD IR camera centered on the same point.*

1.8. ROVER Applications

The ROVER operators, by means of the GoBooks connected to the ROVERs, had access to applications that permitted them to receive FMV, the JBAIIC CIP/CTP, and participate in chat and VoIP supported by Net-T.

1.8.1. VoIP

Net-T VoIP participants included: each of the four ROVER operators, three operators in the TOC (L-3 STE, TOC Commander, and Data), and the aircraft. The VoIP call manager was hosted on a server in the NOC. All VoIP communications were point-to-point with no conference calls. When connectivity existed, VoIP was generally of good quality. The ROVERs suffered frequent breaks in connectivity due to excessive ROVER to Vortex range or aircraft maneuvers. On July 22, the VoIP software option to optimize VoIP for low bandwidth was selected. Users reported this improved the quality of VoIP. VoIP was used for TOC to ROVER operator communications and between ROVER operators.

1.8.2. Chat

All nodes successfully participated in chat**.** The TransVerse chat server in the NOC hosted two chat rooms: Operations and Cursor-on-Target. Chat did not automatically reconnect when the link was broken. Given the frequent loss of link the ROVERs experienced, this was a significant inconvenience.

1.8.3. FMV

The MX-15iHD FMV was transmitted from the aircraft to the ROVERs via Vortex and to the TOC GCS via the Mini TCDL transceiver. The Rack-mounted Data Archive and Retrieval (RDAR) system received the video stream sent to the TOC. Although the MX-15iHD camera produced a superior 1080p E/O image (1920x1080) at 2 megapixels resolution, the ROVERs can receive but not display the FMV in High Definition. On July 23 the ROVER operators reported improved FMV quality as a result of a change in the video encoder settings on the Vortex in the aircraft. The RDAR successfully transmitted real time transcoded (i.e., not HD) MX-15iHD-sourced FMV from the TOC to R2.

1.9. CIP/CTP

All nodes successfully received the CIP/CTP displayed over a FalconView (FV) background. The ROVER nodes displayed it on their respective GoBooks. The CIP/CTP included icons that represented: the BN TOC Precise Participant Location and Identification (PPLI), all four ROVER PPLI, the aircraft PPLI, and the L-3 aircraft Sensor Point of Interest (SPOI).

1.10. Data Archive and Retrieval (DAR)

The Data Archive and Retrieval **(**DAR) is a federated system for FMV archiving, annotation, search, retrieval, and dissemination. It serves as an FMV repository and dissemination point for similar or disparate data formats. The DAR's EchoStorm adLib software's key features involve capturing video and telemetry information, managing it intelligently and efficiently, and disseminating it in near real-time.

A rack-mounted version (RDAR) was hosted in the TOC during Net-T testing and Empire Challenge 2010. The RDAR was located in the NOC with control exercised by operators at a workstation in the TOC. The RDAR adLib video management software was web accessible from the TOC RDAR workstation. The RDAR successfully received, disseminated, and archived the HD FMV from the MX-15iHD sensor on the L-3 aircraft.

1.10.1. RDAR FMV Dissemination

The RDAR passed the MX-15iHD video to the TOC where it was displayed to operations personnel.

The RDAR unicast transcoded FMV to a ROVER (R2) via the Net-T. The transcoded video was lower resolution than the HD FMV received by the RDAR system from the aircraft. The video was transcoded to demonstrate the dissemination of transcoded video to tactical users, and because the ROVER 5 was not capable of displaying HD FMV. The ROVER operator described the received transcoded FMV as clear. It was not possible to demonstrate the dissemination of archived RDAR video to the ROVER because the communications link was not sufficiently robust to allow for the ROVER to query and recover the archived video.

1.10.2. RDAR CoT

The real time RDAR Key Length Value (KLV) metadata stream was converted to Cursor-on-Target (CoT)-formatted messages by RDAR and transmitted to the NOC where the CoT server distributed them to the user FV clients where the L-3 aircraft PPLI icon was displayed, as well as the MX-15iHD SPOI.

1.11. Force XXI Battle Command Brigade and Below (FBCB2)

FBCB2 clients were installed in the TOC and the JRV. The Aircraft CoT PPLI and SPOI messages were converted to Variable Message Format (VMF) and sent to FBCB2 clients in the TOC and JRV where the aircraft PPLI and sensor SPOI were displayed on the FBCB2 workstation, along with the TOC and ROVER PPLI.

11. Findings

The following are the principal findings for the week of July 19 to 23.

- The Net-T architecture supported the distribution of the JBAIIC CIP/CTP to tactical users including four ROVER/GoBook operators.

- The Net-T architecture supported bidirectional chat and VoIP between all tactical units (four ROVERs and the L-3 aircraft) and the TOC.

- For the routes flown by the L-3 aircraft (typically a 12 minute orbit), connectivity between the ROVERs and TOC was not reliable because of the range limitations of the antenna built into the

ROVER and aircraft orientation (loss of connectivity in turns). The external Ku band (downlink) antenna used by some ROVERs (R4 and R1) improved downlink connectivity.

- The communications link from the TOC to the aircraft was reliable with connectivity estimated at more than 90 percent.

- The observed downlink throughput from Vortex to ROVER was generally significantly less than the expected value.

- The RDAR successfully received and archived high definition FMV from the L-3 MX-15iHD sensor.

- The RDAR successfully disseminated transcoded L-3 MX-15iHD-sourced FMV to a tactical user (R2) over Net-T.

- A tactical user (R2) was unable to access the RDAR archive via Net-T due to the unreliability of connectivity.

- RDAR produced CoT formatted messages that provided L-3 aircraft PPLI and MX-15iHD SPOI to the JBAIIC CIP/CTP via the NOC CoT server.

- L-3 sensor SPOI CoT messages were successfully converted to VMF and displayed on FBCB2 clients.

2. JBAIIC in EC10

2.1. Venue

EC10 was executed in from July 26 to August 13 at Fort Huachuca, Sierra Vista, Arizona. The JBAIIC field installation, consisting of Joint Mission Support Module (JMSM) trailers 1, 2, and 3, was located adjacent to the ISIL. The JRV and associated vehicles operated on the east range of Fort Huachuca, located to the northeast of the ISIL as far out as the British Forward Operating Base (FOB) “Delhi”, approximately eight miles from the TOC, and in and around the Urban Operations Area off Garden Canyon Road, about three miles to the southeast of the ISIL.

2.2 JBAIIC Infrastructure in EC10

2.2.1 TOC

In EC10 JBAIIC provided the BN TOC (JMSM 2) and the supporting Network Operations Center (NOC - JMSM 1). JMSM 3 served as an Operations Support Center.

JMSM 2 personnel included:

- BN TOC Commander (CDR).
- S2/S3 (Intel/Ops).
- L-3 controllers for the L-3 Predator surrogate.
- RDAR operators.

The configuration of the JMSM 2 TOC is shown in Figures 3 and 4.

The JMSM 1 personnel included:

- S6 (IT/ Communications support)

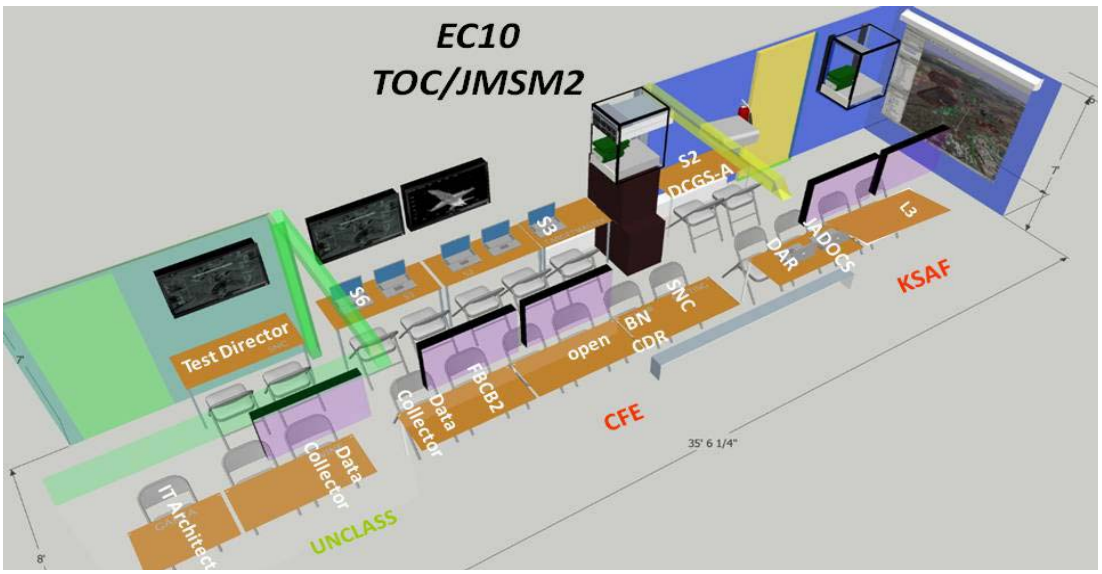

Figure 3. The Layout of the JBAIIC JMSM 2 BN TOC

Note: *The areas allocated to the three classification domains are indicated (Unclassified Common Sensor Network (UCSN), Coalition Four Eyes (SECRET REL USA, GBR, CAN, and AUS), and Kalochistan Security Assistance Force (KSAF) (SECRET REL KSAF[4]), as well as participant workstation locations.*

[4] KSAF was a surrogate for the International Security Assistance Force (ISAF) in Afghanistan. Although ISAF was comprised of 43 nations during July/August 2010, only 14 nations signed the required information sharing agreements with the Defense Information Systems Agency (DISA) to access the KSAF domain and participate in EC10.

Figure 4. Interior of the JMSM 2 TOC on August 12, 2010

Note: *The image was taken with the photographer standing in the UCSN section of the trailer looking though the CFE section to the KSAF section at the far end.*

2.2.2 Field Operations

Field operations were centered on the JRV and associated support vehicles**.** JRV personnel consisted of mounted and dismounted Joint Terminal Attack Controllers (JTAC) and Joint Forward Observers (JFO).

Figure 5. The JRV

Note: *The whip antennas on the rear bumper are for the AN/PRC-117F radio, the three dipole antennas on the roof are for AN/PRC-117G radio, and the small tripod-mounted antenna near the center of the roof is a ROVER omni-directional Ku band downlink antenna.*

Figure 6. The Interior of the JRV

Note: *The image is of the CFE operator's position. The large display at upper right is the JRV CFE client. The small display just right of center is FBCB2. The KSAF operator is to the left, facing rearward.*

2.2.3. Networks

JBAIIC operated on three EC10 networks: Coalition Four Eyes (CFE), Kalochistan Security Assistance Force (KSAF) and Unclassified Common Sensor Network (UCSN). JMSM 1 and 2 were each divided into three physical areas, one supporting each domain (see Figure 3). The JRV operated on two security domains, KSAF and CFE. The JBAIIC Liaison Officer in the ISIL operated on KSAF and UCSN. JBAIIC EC10 activities were concentrated on the KSAF domain.

The JBAIIC EC10 network architecture for the TOC, NOC, JRV, and dismounted personnel is shown in Figure 7. In the Net-T testing, L-3 communications were run unencrypted and UNCLASSIFIED. In EC10, the Net-T capability was removed but all L-3 hardware continued to participate encrypted on the KSAF network. Operationally, the difference between Net-T and EC10 L-3 testing was that in EC10, the multiple ROVERs, with one exception, were "receive only" and could not transmit. The one exception was the ROVER in the JRV.

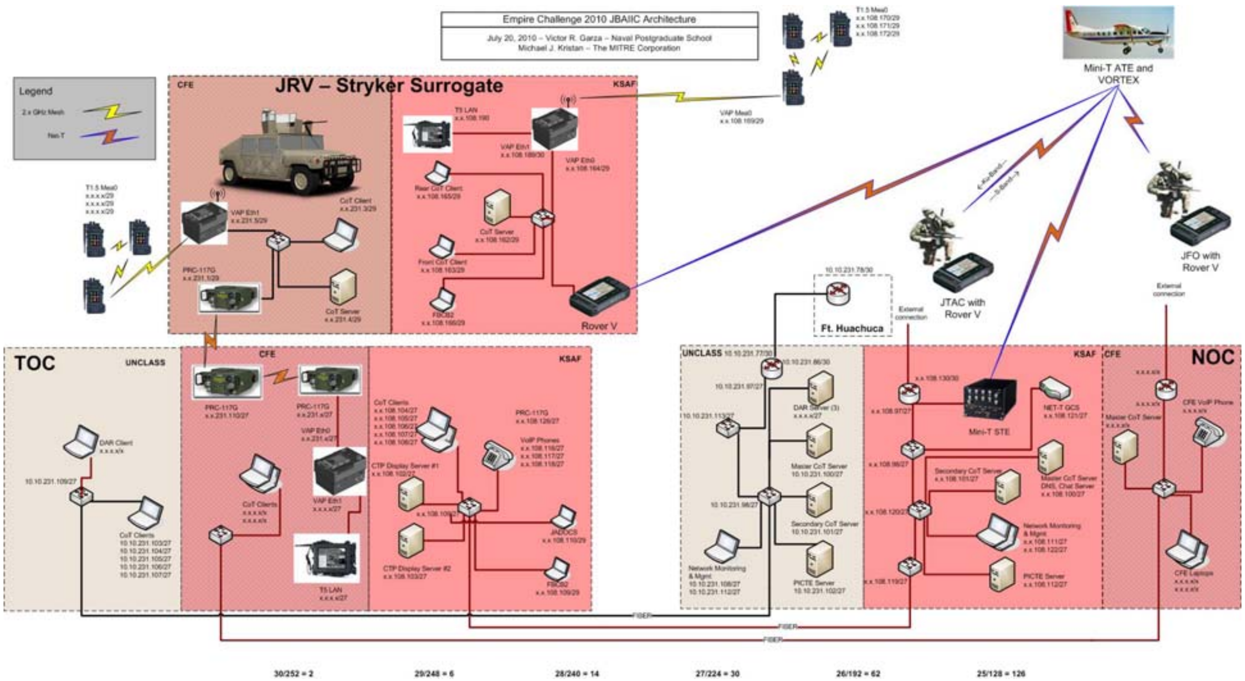

Figure 7. JBAIIC Network Architecture in EC10

Note: *This figure is shown at higher resolution in Appendix 8.*

2.2.3.1 Cross-Domain Data Transfer

Cross-domain data flows were handled by the Raytheon High Speed Guard (HSG). Figure 8 presents the JBAIIC cross-domain flows. In general, the guard was intended to perform as follows:

- All data were to flow from lower to higher security domains. This was to include images but that was not accomplished in EC10.

- A limited number of messages related to CoT taskers were to move through the HSG from CFE to KSAF (high to low) but this was not accomplished in EC10.

Cross domain data transfer is dealt with in more detail in subsequent sections - notably Section 2.4.1.

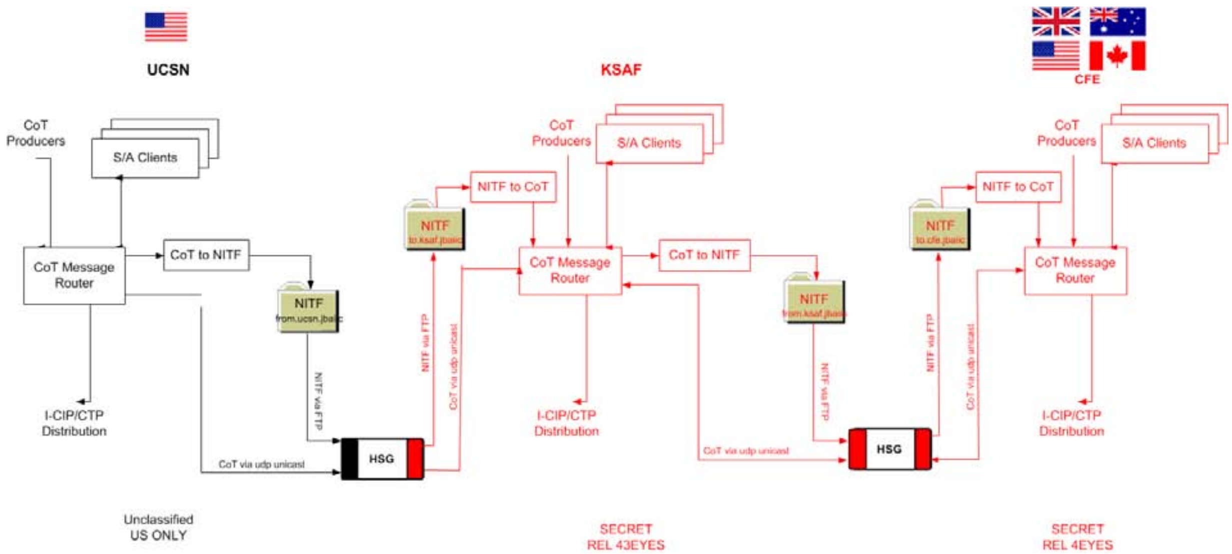

Figure 8. Cross Domain Data Flows in EC10

2.2.4 Communications

There were three primary communications links between the TOC and the JRV:

- The TOC-JRV KSAF link was supported via the L-3 Predator surrogate aircraft.
- The TOC-JRV CFE link was Line-of-Sight (LOS) using the PRC-117G radio. This link was only used for data transfer.
- TOC-JRV LOS voice communications using the PRC-117F radio.

For voice communications with the JRV, the TOC used (in order of priority): PRC-117F radio, Land Mobile Radio System (LMRS) range radio, and conventional phone. The latter were used primarily when the TOC-JRV range was beyond the range of the PRC-117F (about eight miles – see Appendix 5)

Data communications were intended to be primarily by the L-3 link, with the PRG-117G LOS communications as a backup. In practice, much of the TOC-JRV data communications were via the PRC-117G. This was primarily due to the unreliable ROVER-Vortex communications that resulted from the limited Vortex-ROVER range, and Libby Army Airfield air operations restrictions that did not always permit moving the L-3 aircraft to orbits that would optimize the communications link. When located in the Urban Operations Area off Garden Canyon Road, the L-3 link was reliable. The aircraft orbit was such that the aircraft to ground station link was solid and the JRV to aircraft range was normally within the ROVER-Vortex range limits. L-3 communications were problematic when the JRV

was located in the vicinity of the British (GBR) Forward Operating Base (FOB) on East Range. Airspace control restrictions limited how far north the orbit of the L-3 aircraft could be shifted and the JRV was often beyond the ROVER- Vortex range limit.

All communication means used between the TOC and other EC10 participants are listed in Table 3.

Table 3. TOC Communications Links Used in EC10

Communications means	Who	Primary Use	Comments
L-3 ROVER/Vortex	TOC-JRV	CIP/CTP to JRV, nine-line to TOC	KSAF
PRC-117G	TOC - JRV	CIP/CTP to JRV, nine-line to TOC	Data only. CFE
PRC-117 F	TOC - JRV	Voice comms	
PRC-117 F	JRV - F-16C	Manage CAS missions	TOC monitor CAS
LMRS Range radio	TOC - JRV	Coordination with TOC JRV follow-on vehicles and other EC10 nodes (e.g., BETSS-C)	
JBAIIC TransVerse chat	TOC, JRV, ISIL TOC LNO, SE	TOC-LNO comms LNO-SE coordination	On all three domains in TOC. Little used for JRV TOC comms
Adobe Connect	TOC, TOC LNO multiple other EC10 nodes	Coordination between TOC, TOC LNO and other EC10 nodes.	KSAF. Used for limited interval in EC10
Adobe Connect	TOC, other EC10 nodes	AOCO sent tracks to TOC for insertion into CFE CIP/CTP	CFE. Start August 6
CDCIE	EC10	Did not receive in TOC	Primary EC10 chat. JBAIIC CDCIE incompatible with confirmation of TOC workstations.
VoIP	TOC- ISIL	Comms to TOC LNO in ISIL. Limited use.	KSAF
Commercial phone	TOC-JRV	Communication from field to TOC when out of PRC-17F range.	
L-3 chat	L-3 GCS and L-3 A/C	C2 and trouble shooting	L-3 use only
L-3 VoIP	L-3 GCS and L-3 A/C	C2 and trouble shooting	L-3 use only
Cellphone	L-3 GCS and L-3 A/C	C2 and trouble shooting	L-3 use only

2.2.5 Tools and Applications

2.2.5.1 Chat

At the start of EC10 the TOC had only JBAIIC TransVerse chat on each of the KSAF, CFE, and UCSN networks with no cross-domain capability. Each network had an Operations chat room and a CoT chat room for technical discussions. The UCSN network also had an ARL UGS chat room. These chat rooms were hosted on servers in the NOC. There were a limited number of EC10 participants in these chat rooms; principally TOC personnel, BN TOC LNO in the ISIL, ScanEagle UAS GCS, and ARL UGS. Given the lack of Cross Domain Collaborative Information Environment (CDCIE) chat in the early phases of EC10, Adobe Connect was introduced on the KSAF and CFE networks (not cross-domain) for general EC10 use. When CDCIE became available at most EC10 nodes, the use of Adobe connect was discontinued (August 5) in favor of CDCIE. Since the installation of CDCIE in the TOC was incompatible with the configuration of the TOC computers, Adobe Connect chat remained in use there but, with few other users, it was of limited value. It was used most notably for communications between the TOC and Airborne Overhead Cooperative Operations (AOCO) personnel for the last week of the experiment. The TransVerse chat hosted in the NOC remained the primary JBAIIC TOC chat tool throughout EC10.

2.2.5.2. JTAC Tools: TCAP CASS and BAO Kit

Tactical Air Control Party Close Air Support System (TACP CASS) and Battlefield Air Operations Kit (BAO Kit) are JTAC applications for conducting digital Close Air Support (CAS) missions. Rockwell Collins provided version 1.4.2 of the TACP CASS software and it was loaded on both KSAF and CFE clients in the JRV. The latest version of BAO Kit (version 4.1) was also loaded on the KSAF and CFE clients. BAO Kit was also loaded on the SNC Tacticomp T5 devices.

2.2.5.3. FalconView (FV)

All JBAIIC operators used FV for displaying the CIP/CTP.

2.3. JBAIIC Initiatives

2.3.1. U.S. Army/EchoStorm Data Archive and Retrieval (DAR)

The role of RDAR in EC10 was similar to that in Net-T testing:

- Receive and archive imagery from ISR sources in EC10, particularly the L-3 Predator surrogate sensors.

- Provide Predator surrogate imagery display for the TOC.

- Provide the Predator surrogate and the Base Expeditionary Targeting and Surveillance Systems – Combined (BETSS-C) PPLI and SPOI CoT data streams to the KSAF CoT server.

- Disseminate FMV to tactical users, specifically the JRV.

2.3.2. Sierra Nevada Corporation (SNC)

SNC participated in EC10 testing beginning on August 3. The SNC devices permitted JTAC/JFO participation in Digitally-aided Close Air Support (DCAS) operations while mounted or dismounted. SNC provided Versatile Access Point (VAP) wireless routers, and Tacticomp T1.5 and T5 hand-held militarized tablet computers in support of EC10, distributed as indicated in Figure 7. The T1.5s and T5s associated with a given VAP formed a mesh network with a maximum range of about 1.3 statute miles between the VAP and the tablet computers. All SNC devices in the mesh network associated with the JRV VAP provided PPLI that were displayed in the CIP/CTP. The T5s displayed FMV disseminated to tactical users by the RDAR.

The T5s displayed the CIP/CTP on FV and were loaded with TransVerse chat and BAO Kit. They were not loaded with TACP CASS.

2.3.3. L-3

The role of L-3-provided communications in EC10 was the same as it was in Net-T testing. The principle difference was that in the Net-T testing L-3 communications were run unencrypted and UNCLASSIFIED. In EC10, the Net-T capability was removed but all L-3 communication hardware was run encrypted on the KSAF network. In operational terms, this meant the multiple ROVERs, with one exception, were “receive only” and could no longer transmit. The one exception was the ROVER in the JRV, which continued to have an uplink capability. In EC10, this external antenna was used for both downlink to the ROVER and uplink to the Vortex; in Net-T testing the external antenna was used only for downlink.

The MX-15iHD sensor on the L-3 Predator surrogate provided imagery to support DCAS operations.

2.3.4 Force XXI Battle Command Brigade and Below (FBCB2)

As in Net-T testing, FBCB2 clients were installed in the TOC and the JRV. Aircraft CoT PPLI and SPOI messages were converted to Variable Message Format (VMF) messages and sent to the FBCB2 clients in the TOC and JRV where the sensor PPLI, SPOI, and FOV were displayed (this included the L-3 Predator surrogate, ScanEagle, and BETSS-C) on the FBCB2 workstation, along with the rest of the KSAF CIP/CTP. During DCAS testing, when the strike aircraft Link-16 feeds were functional, the

strike aircraft PPLI were displayed on FBCB2. However, the strike aircraft targeting pods[5] SPOI were never received from the aircraft so they could not be displayed on FBCB2.

2.3.5 National Reconnaissance Office Airborne Overhead Interoperability Office

The National Reconnaissance Office's (NRO) Airborne Overhead Interoperability Office (AOIO) is developing methods for the effective correlation of the vast amounts of ELINT data from multiple sources. Extensive utilization of information fusion tools is essential to this effort. Therefore AOIO has developed the Airborne Overhead Cooperative Operations (AOCO) Joint Interface Control Document for ELINT operations, providing a standardized messaging format for electronic emitter data. This format is key to cooperative geolocation efforts; if followed, time snapshots of data from various ELINT collectors, including Radar Warning Receivers (RWR) and other non-traditional sources, can be merged to refine the location of an emitter, which then can be compared to information collected by other intelligence means to further enhance geolocation efforts.

Conducting their own capability demonstration during EC10, AOCO did not have the ability to inject its targets into EC10 strike operations for subsequent engagement. In the final week of EC10 the JBAIIC BN TOC became AOCO's routine means for this to be accomplished. This is illustrated by the following example:

August 11

An AOCO track was provided to the TOC via CFE Adobe Connect chat.

8:58. the TOC S3 created a track (GT7) that appeared in the CFE CIP/CTP.

The S3 verbally passed the target to the L-3 Predator surrogate operators in the TOC.

9:30. The S3 observed a target in MX-15iHD imagery that was identified as the AOCO target (two poles with a wire array stretched between them).

9:35. The S3 passed the target by voice and chat to the JRV.

The JRV planned to send a nine-line to the F-16C strike aircraft but the aircraft do not have link to the Link-16 gateway.

10:28. JTAC verbally passes target coordinates to the F-16C.

10:30. JRV receives F-16C targeting pod video. Pilot describes the image of the two poles with the wire array.

[5] Depending on F-16C variant, LITENING or SNIPER targeting pods may have been present on the aircraft.

2.4. JBAIIC EC10 Missions

The missions assigned to the JBAIIC TOC in EC10 included the following:

- Create and disseminate a CIP/CTP on multiple security domains.
- Provide and support mounted and dismounted JTACs in executing DCAS missions.
- Manage the ScanEagle UAS Intelligence Surveillance Reconnaissance (ISR) asset. This ScanEagle ISR management role was performed by the JBAIIC liaison in the ISIL.
- Provide direction to Base Expeditionary Targeting and Surveillance Sensors-Combined (BETSS-C) ISR asset.
- Provide direction to the L-3 Predator surrogate.
- Support AOCO by manually injecting tracks into the Coalition Four Eyes (CFE) CIP/CTP, and manage the prosecution of those targets.
- Make all EC10 FMV streams accessible to operational personnel in the TOC.
- Provide FMV to tactical users (i.e. JRV).

2.4.1. JBAIIC CIP/CTP

A CIP/CTP was produced in the NOC for each of the UCSN, KSAF, and CFE domains. The CIP/CTP was available in the TOC on all three domains and in the JRV on the KSAF and CFE domains. External to JBAIIC the CoT CIP/CTP data stream was provided to consumers on multiple domains. These consumers included:

UCSN network:

- ScanEagle
- Constant Hawk
- Army Research Laboratory (ARL)
- BN TOC LNO (ISIL)

KSAF network:

- BETSS-C

- Distributed Common Ground Station - Army (DCGS-A)
- FBCB2 (clients in the TOC and JRV. Data stream converted from CoT to VMF in the NOC)
- ROVERs (CIP/CTP displayed on GoBooks)
- Joint Intelligence Laboratory (JIL)
- BN TOC LNO (ISIL). This feed was pushed to a large screen display and was available to all ISIL participants.

The CIP/CTPs on the different domains do not, in fact, represent a "common" picture. The HSG passed tracks only from lower to higher domains so the CIP/CTP was unique on each domain with more information generally available on the CIP/CTP resident on the higher security domains.

The HSG guard appeared generally effective at passing data to higher security domains with the following observed exceptions:

- UGS imagery was accessible from the CIP/CTP on the UCSN domain. These images were to be passed through the HSG and displayed on the higher domains but this was not accomplished in EC10.

- On one occasion, there were eight DTRA alerts listed for the KSAF domain but only one was passed to the CFE domain.

- In the TOC, a track was created in the KSAF domain and was displayed on the KSAF CIP/CTP but was not passed to the CFE CIP/CTP.

Table 4. The JBAIIC CIP/CTP Content as a Function of Domain

Track	Comment
UCSN	
SE PPLI, SPOI and FOV	
TOC PPLI	TOC call sign was Rock Steady
ARL UGS PPLI	
ARL UGS detection alert	Manifested as image available
ARL UGS images	First accessible Aug. 6. UCSN only. These images were never successfully passed through the HSG to the KSAF and CFE CIP/CTPs.
Terra Harvest PPLI	UGS
Terra Harvest images	
BFT	First available Aug. 4.
KSAF	
SE PPLI, SPOI and FOV	
TOC PPLI	
ARL UGS PPLI	

ARL UGS detection alerts	
L-3 Predator surrogate PPLI and SPOI	Via RDAR.
BETSS-C PPLI and SPOI	Via RDAR
JRV/JTAC PPLI	Via ROVER GoBook. JRV/JTAC call sign was Killer
T5 JRV PPLI	SNC T5 associated with Killer
JADOCS targets and strike tasks	
TACP CASS/ BAO target	
BFT	First time available Aug. 4.
DTRA plumes	First observed Aug. 6.
DTRA biochemical alerts	CoT messages disseminated by CoT server but not displayed in CIP/CTP because there were no corresponding icons.
Surveillance tasker	
Constant Hawk PPLI and SPOI	
Pluto	GMTI fused tracks
Terra Harvest	
Bareback nine-line	An array of icons including: target icon, tasking icon, and JTAC position
CFE	
SE PPLI and SPOI	
TOC	
ARL UGS PPLI	
ARL UGS targets	
L-3 Cessna PPLI and SPOI	Via RDAR.
BETSS-C PPLI and SPOI	Via RDAR
Killer PPLI	JRV. Via ROVER GoBook
T1.5 JRV PPLI	SNC handheld associated with Killer
T5 JRV PPLI	SNC handheld associated with Killer
Link-16 tracks	As of Aug. 4 saw first F-16C tracks
JADOCS targets and strike tasks	
TACP CASS/ BAO target	
Bareback nine-line	An array of icons including: target icon, tasking icon, and JTAC position
DTRA plumes	First observed Aug. 6.
DTRA biochemical alerts	CoT messages disseminated by CoT server but not displayed in CIP/CTP because there were no corresponding icons.
Surveillance tasker	
Terra Harvest PPLI	UGS
TPG	
BFT	
AOCO	Tracks injected by TOC S3

Constant Hawk PPLI and SPOI	
Pluto	GMTI fused tracks

Note: *Shaded blocks indicate tracks available only on the CFE CIP/CTP.*

2.4.2. Digitally Aided Close Air Support (DCAS)

A primary mission of the JBAIIC TOC in EC10 was to support the JRV-mounted JTACs in executing DCAS missions. This support included transmitting the JBAIIC CIP/CTP to the JTAC, and receiving a nine-line brief (air support call), from the JTAC and relaying the digital targets and tasking to the strike aircraft. The intended primary communications link for accomplishing this was the L-3 GCS in the TOC, the L-3 airborne Vortex, and a ROVER 5 on the JRV. This was a KSAF communications link. The backup link was the PRC-117G LOS TOC-JRV communications on the CFE network.

The strike aircraft participating in EC10 were Arizona Air National Guard F-16Cs from the 162nd Fighter Wing. During the week of August 2-6 the F-16Cs were Block 30 and were Situation Awareness Data Link (SADL)-equipped. For the interval August 10-12 the F-16Cs were Block 40 and Link-16-equipped.

The F-16Cs flew strike and CAS missions. During the CAS missions the F-16C strike assets were shared between British JTACs who conducted voice CAS missions and the JBAIIC JTACs who conducted DCAS missions. During the strike missions, the British and JBAIIC JTACS did not participate but were available as backup and to conduct CAS missions if the F-16Cs had remaining on-station time after the completion of the planned strike mission. The planned F-16C mission schedule for EC10 is listed in Appendix 4.

During some of the CAS missions the F-16Cs could not establish link with the network (e.g., Aug. 4 AM, Aug. 6 PM, Aug. 10, and Aug. 11 AM). This meant they could not receive the DCAS targets and tasking, and the strike aircraft positions were not displayed on the CFE CIP/CTP. DCAS messages were successfully sent to, and received by the F-16C aircraft on Aug. 5, 11, and 12 (see Table 5).

The week of August 2-6, the F-16Cs were equipped with LITENING pods, but frequency restrictions did not permit their use. Consequently, there was no strike aircraft video available on ROVER and no SPOI was sent to FV for display. The week of August 10 the aircraft carried the SNIPER pod. During that week, imagery was received for some sorties but no SPOI were received.

During the first week, all DCAS communications with the aircraft were unencrypted. During the second week, two days of encrypted communications were scheduled.

All voice communications between JBAIIC JTACs and the F-16Cs were by PRC-117F.

2.4.2.1. Strike Asset Assignment to the JBAIIC JTAC

The assignment of strike assets to the JBAIIC JTACs proceeded as follows in EC10:

- The JRV JTAC passed the need for strike aircraft to the TOC.
- The TOC passed the request to the Air Boss who, depending on the scenario, could be located on the Airborne Warning and Control System (AWACS) or Joint Surveillance Target Attack Radar System (JSTARS) aircraft, or in the ISIL.
- The strike aircraft checked in with the Air Boss when arriving in the operations area. When appropriate, the Air Boss chopped the aircraft to the JBAIIC JTAC.
- The strike aircraft and the JTAC then communicated directly to execute the CAS mission.

In practice, the JBAIIC JTAC bypassed the TOC and communicated directly with the Air Boss.

Table 5. Strike Aircraft DCAS Missions as Executed in EC10

Date	Time	Aircraft	Comments
August 12	PM	F-16C Block 40 Link-16. SNIPER Pod	Four targets received by the aircraft. Sent via T5 CFE. In three of the four cases the target was created with the TACP CASS application of the JRV CFE client. The target was passed via the network to the T5 Bareback application. F-16C pod imagery seen in JRV.
August 12	AM	F-16C Block 40 Link-16. SNIPER Pod	Two missions received by the aircraft. From T5 and JRV KSAF clients. Aircraft received both J3.5 and J12 messages. JRV receiving SNIPER Pod imagery on ROVER. ROVER imagery pushed from JRV to TOC.
August 11	PM	F-16C Block 40 Link-16. SNIPER Pod	Sent multiple (2-3) J 3.5 messages to the aircraft. JRV CFE client and CFE T5 generated Bareback nine-lines. Mission aborted because target not seen on aircraft pod imagery (target geo-refinement issue). Need to pre-define format of target coordinates. Aircraft pod imagery on ROVER in JRV. JRV needs to voice transmit remainder of nine-line since aircraft only getting J3.5 via DCAS. No aircraft SPOI observed.
August 11	AM	F-16C Block 40 Link-16. SNIPER Pod	F-16Cs no network link (Timber Sour). No DCAS missions. JBAIIC JTAC sent target coordinates to F-16C via voice. SNIPER pod imagery received in JRV. Imagery shows target sent by JRV.
August	AM	F-16C Block 40	Strike mission cancelled. Aircraft available for CAS.

10		Link-16. Encrypted	Both F-16Cs had no link (possible encryption issue). No ROVER feed. British JTACs did voice CAS with F16s. No DCAS. KSAF T5 sent nine-line to TOC. CFE JRV client sent nine-line to TOC.
August 10	PM	F-16C Block 40 Link-16 Encrypted	Both F-16Cs no link (possible encryption issue). Brits did voice CAS. No DCAS.
Aug 9		No aircraft	
August 6	AM	F-16C Block 30 SADL. LITENING Pod	Strike mission no DCAS
August 6	PM	F-16CBlock 30 SADL. LITENING Pod	F-16Cs can't link to gateway. British JTACs do voice CAS. No DCAS. JRV CFE client nine-lines sent to NOC.
August 5	AM	F-16C Block 30 SADL. LITENING Pod	Nine-lines sent from JRV CFE client. F-16C received target; reads back coordinates from display. Confusion between pilot and JTAC regarding target track number. T5 cannot link up to Vortex.
August 5	PM	F-16C Block 30 SADL. LITENING Pod	After completion of strike mission, JBAIIC JTAC attempted to send a nine-line to the F-16C via the JRV KSAF client. The aircraft received a J3.5 message.
August 4	AM	F-16C Block 30 SADL. LITENING Pod	Neither aircraft could connect to gateway (Timber Sour); therefore no DCAS. JBAIIC JTAC provided voice nine-line then passed control to British JTACs (Widow 25)
August 4	PM	F-16C Block 30 SADL. LITENING Pod	JRV JTAC attempted to send digital nine- lines to F-16C from both CFE client and CFE T5. They were received in NOC but not by aircraft. F-16Cs released to preplanned strike mission.
August 3	AM	F-16C Block 30 SADL. LITENING Pod	Strike mission; No DCAS.
August 3	PM	F-16C Block 30 SADL. LITENING Pod	No DCAS.
August 2	AM and PM	F-16C Block 30 SADL. LITENING Pod	British JTACS voice CAS. No DCAS

Note: *The shaded blocks indicate those missions where the F-16Cs received and acknowledged DCAS messages from the JBAIIC JTACs.*

2.4.2.2. JBAIIC DCAS Procedures

The original intent for EC10 was to generate the nine-line briefs in TACP CASS and transmit them, via the NOC, to the strike aircraft. But the version of TACP CASS (version 1.4.1) used in EC10 could not produce nine-line briefs in CoT format, but solely in VMF. However, the VMF nine-line messages could not go through the routers; therefore, the TACP CASS nine-lines needed to be converted to CoT format. Rockwell Collins is developing a TACP CASS version that produces CoT messages, but in the absence of CoT from TACP CASS, the nine-line had to be produced by BAO Kit, which can provide CoT format. In EC10, the initial target track message was often produced in the TACP CASS application and this target message, received by BAO Kit, was the basis for the BAO Kit CoT nine-line. The TACP CASS VMF target message was converted to CoT format by a MITRE VMF to CoT application. (However, this application cannot convert the VMF nine-line to CoT.) The BAO Kit Bareback [6]application target location was automatically populated when TACP CASS generated the target location. When the target location was not produced in TACP CASS, it was generated in BAO Kit.

The CoT nine-line was converted to J message format required by the F-16C strike aircraft. To accomplish this, the Bareback CoT nine-line went to the Multi TADIL Converter Daemon (MTCD) in the NOC where it was converted to J message format. These J messages were passed to a Joint Range Extension (JRE) for transmission via SADL or Link-16 to the F-16Cs. SADL was used for the week of August 2 with the Block 30 F-16Cs and Link-16 was used for the week of August 9 with the Block 40 F-16Cs.

The Bareback "CoT nine-line" actually consists of four CoT messages:

- Target track
- JTAC location
- Tasking to engage
- Initial point

There are not J messages that correspond to each of these CoT messages. As of the end of EC10, two J messages could be sent to the strike aircraft:

- Target location (J3.5)
- Tasking message (J 12)

However, these J series messages do not convey all of the information contained in a traditional voice CAS nine-line brief. These include:

1. Initial Point

[6] The BAO Kit uses the Air Force Research Lab-developed Bareback software as a CoT gateway to the Global Information Grid.

2. Heading
3. Distance
4. Target Elevation
5. Target Description
6. Target Location
7. Type Mark
8. Location of Friendlies
9. Egress and Remarks

If the target was identified as friendly or neutral in the Bareback application, a J3.5 message would be sent. If the target was identified as hostile, a J12 message would be sent, but only if the strike aircraft was identified in the tasking message. An arbitrary target aircraft was automatically inserted in the NOC to permit the J12 to be sent. Thus, the F-16C strike aircraft did receive DCAS messages in EC10 but they did not receive the full array of information that is might be contained in a digital nine-line brief.

The JBAIIC NOC was assigned J-track block numbers 07541-07677 for hostile tracks and 07501-07540 for neutral or friendly tracks. MITRE developed code so that when a track number was automatically assigned in the NOC, the track number was sent to the JRV. Both the JTAC and the strike aircraft could then refer to the same track number in discussing a specific target.

In EC10 there were no direct data transmissions from the JBAIIC JTACs to the strike aircraft. All DCAS data communications to the aircraft flowed through the JRE and SADL/Link-16.

There appeared to be a lack of understanding on the part of both the F-16C pilots and the JTACs about exactly what information was being passed between them. The aircraft were receiving a subset of the information from the nine-line being transmitted to them but they were not presented with all the information contained in the BAO Kit-generated nine-line. In at least one instance, the JTAC asked the pilot for a read back of the target coordinates. The pilot read the coordinates of the target icon that had appeared on his display. The coordinates differed from those of the target in the nine-line by only a few meters so they were clearly the same object. But the pilot did not have access to the precise target coordinates.

The GetNineLines application was installed on computers in the TOC so operators could view the nine-line content.

2.4.2.3. DCAS scenarios

The targets sent to the strike aircraft were generally arbitrary target locations and were unrelated to EC10 scenarios. The DCAS missions were for demonstration/training purposes for/of aircrew and JTACs.

2.4.3. Imagery

2.4.3.1. FMV Imagery in the TOC

A variety of video streams accessed in a variety of ways were accessible in the TOC. Table 6 lists the FMV sources, how they were accessed, and how they were displayed. Essentially all video displayed in the TOC was displayed for demonstration purposes. Little of this FMV was used operationally in the execution of BN TOC missions. The primary exception to this was the Predator surrogate imagery that was viewed in the prosecution of several AOCO targets.

Table 6. FMV Displayed in the TOC

Video Source	How accessed	How displayed	Network	Comment
MX-15iHD EO	1. L-3 GCS in TOC. 2. Valiant Angel. 3.Direct feed	1.L-3 GCS TOC display 2.RDAR work station 3. TOC CDR laptop	KSAF	
MX-15iHD IR	1. L-3 GCS in TOC 2. Direct feed	1. L-3 GCS TOC display 2.RDAR work station	KSAF	
BETSS-C	1. Direct feed 2.Valiant Angel 3. RDAR	1.TOC CDR laptop 2. RDAR work station	KSAF	
ScanEagle	direct feed	UCSN data laptop	UCSN	
ScanEagle	1.Direct feed 2.Valiant Angel	TOC CDR laptop	KSAF	
PGSS	1.Valiant Angel 2.Direct feed	TOC CDR laptop	KSAF	
Cortez	Valiant Angel	TOC CDR laptop	KSAF	
Canadian Aerostat	Valiant Angel	TOC CDR laptop	KSAF	
Green Devil	Valiant Angel	TOC CDR laptop	KSAF	
Cerberus	Valiant Angel	TOC CDR laptop	KSAF	
Constant Hawk	RDAR	RDAR display	KSAF	First displayed Aug. 11
F-16C SNIPER Pod	KSAF network	ROVER 5 in TOC	KSAF	Sent from JRV but only a few frames received before

				aircraft out of range of the JRV. From ROVER on roof of ISIL to TOC.
F-16C LITENING Pod	NA	NA		Frequency conflicts did not permit use. No imagery received.
BETSS-C	NOC	TOC CFE monitor	CFE	This was the only imagery seen in the TOC on CFE. First displayed Aug. 11

2.4.3.2. FMV Imagery in the JRV

The sources of the FMV displayed in the JRV are listed in Table 7.

Table 7. FMV Received in the JRV

Video source	How accessed	How displayed	Network	Comment
MX-15iHD EO	from L-3 A/C to ROVER 5 in JRV	ROVER 5 or GoBook	KSAF	Not HD
MX-15iHD IR	from L-3 A/C to ROVER 5 in JRV	ROVER 5 or GoBook	KSAF	Not HD
BETSS-C	RDAR-GCS-Vortex- ROVER	JRV client SNC T5	KSAF	Image quality ranged from good to poor. Unicast.
MX-15iHD	RDAR-GCS-Vortex- ROVER	JRV client SNC T5	KSAF	Image quality ranged from good to poor. Unicast Transcoded.
Constant Hawk	RDAR-GCS-Vortex- ROVER	JRV client SNC T5	KSAF	Image quality ranged from good to poor. Unicast.
F-16C SNIPER Pod	ROVER	ROVER and JRV clients	KSAF	
F-16C LITENING Pod	NA	NA		Frequency conflicts did not permit use. No imagery received.

2.4.3.3. Multicast

Throughout EC10 there were problems with multicast on the KSAF network. The effect was to limit access to various streamed FMV feeds. The RDAR operator stated the multicast restriction severely affected RDAR operations and limited RDAR's utility in EC10.

2.4.3.3. Still Imagery

As of 6 August, ARL UGS images were accessible from icons in the CIP/CTP FV display on the UCSN network. These images were converted from CoT messages with embedded images into NITF for sending to the HSG (see Figure 8 for data flow). The subsequent NITF files were passed through the HSG to the KSAF network. An unresolved network connectivity problem arose when the HSG attempted to send the NITF images to the JBAIIC NOC. The problem may have been related to the network connectivity issues on the KSAF network. The plan was to take these NITF files and recreate the associated CoT messages for dissemination to the KSAF CIP/CTP. A similar process would be used to pass the images from KSAF to the CFE enclave. As a result of these problems, the UGS images were accessible only on the UCSN domain.

2.5. EC10 Findings.

- The objective in Empire Challenge experimentation is generally to demonstrate data exchanges and collaboration; the primary goal is not to create realistic free-play scenarios. Therefore, at least some of the scenarios should be tightly scripted defining who conducts what actions at what times. This would help participants understand their roles and focus attention on demonstrating specific data exchanges and collaborations.

- Nine-line messages were developed by JRV clients and SNC Tacticomp T5s and transmitted on both the LOS PRC-117G (CFE) net and the L-3 communications airborne relay (KSAF) to the NOC for dissemination to strike aircraft.

- TOC to JRV communications over the L-3 communications link were often unreliable. This was primarily due to the limited Vortex-ROVER range and Fort Huachuca air operations restrictions that did not permit freely moving the L-3 aircraft to orbits that would optimize the communications link.

- DCAS messages were received and acknowledged by the F-16C strike aircraft. The messages received were J3.5 and J12 messages but the aircraft did not receive complete digital nine-line information. A digital standard for the nine-line brief and the on-station reports issued by aircraft has not yet been implemented by the U.S. Military.

- The original intent for EC10 was to demonstrate TACP CASS as the principal JTAC DCAS application. But the current version of TACP CASS can only produce VMF nine-lines not CoT

nine-lines. The VMF nine-lines could not be converted to CoT as required by the DCAS methodology implemented in EC10. Therefore all nine-lines were produced by BAO Kit that can produce CoT nine-lines.

- The F-16Cs operated encrypted only on August 10. The aircraft were not able to establish link with the gateway, possibly due to encryption issues. Therefore all DCAS missions executed in EC10 were conducted unencrypted.

- MITRE developed code so that the track number automatically assigned in the NOC was passed to the JTAC. Thus, both pilot and JTAC could refer to a given target with the same track number. This improved the efficiency of CAS operations.

- JTACs and technical personnel should participate, remotely if necessary, in aircrew mission briefs and debriefs.

- Pre-experiment collaboration is required between JTACs, flight crews, and technical personnel to precisely define data exchanges, data formats, and units to be used (e.g., geographic coordinate format). Ideally, pre-experiment data exchanges will be demonstrated with the aircraft.

- The JBAIIC NOC created and disseminated CIP/CTPs for the UCSN, KSAF, and CFE security domains. The information available in each of those domains is indicated in Table 4. The KSAF and CFE CIP/CTP were available to tactical users in the JRV on both JRV clients and the SNC T5 devices. Other tactical users equipped with ROVERs accessed the KSAF CIP/CTP on GoBooks.

- The RDAR successfully transmitted transcoded FMV to tactical users in the JRV. The imagery was displayed on the JRV clients and the SNC T5 devices. FMV imagery from the Predator surrogate, BETSS-C, and Constant Hawk were disseminated over the L-3 KSAF communications link. Tactical users were not able to retrieve imagery from the RDAR repository because the link was not sufficiently stable.

- Throughout EC10, there were problems with multicast on the KSAF network. The effect was to limit access to various FMV streams. The multicast restrictions severely affected RDAR operations and limited its utility in EC10.

- FBCB2 successfully displayed the PPLI, SPOI and FOV of a variety of sensors. F-16C PPLI were displayed on FBCB2 but the aircraft did not send their sensor/targeting pod SPOI so that could not be displayed.

- The TOC was able to access FMV from a variety of sources by a variety of means. Sources included: Predator surrogate, ScanEagle, BETSS-C, Constant Hawk, PGSS, Cortez, Canadian aerostat, Green Devil, and Cerberus. Means of access included direct access, Valiant Angel, and RDAR. HSG and multicast issues constrained multi-domain distribution of FMV.

- The TOC received AOCO tracks and injected those tracks into the CFE CIP/CTP. These tracks were investigated with the Predator surrogate sensors and, in at least one instance, the target was passed to F-16C strike aircraft.

- The JBAIIC TOC was not able to employ CDCIE chat and therefore could not access the primary EC10 collaboration tool. The TOC systems need to be configured so that they are compatible with CDCIE.

- JBAIIC needs to optimize the PRC-117F and PRC-117G antennas for the specific communications requirements of the exercise.

- JBAIIC needs to maintain a log as to how each PRC-117 radio is configured.

- The TOC needs two PRC-117F radios for CAS. During CAS operations the TOC often needed to change frequencies. It would be more efficient to have two radios permanently set to the two required frequencies.

3. Assessment of JBAIIC Net-T and EC10 Objectives

This section lists and provides assessments for the objectives and objective questions that were developed for JBAIIC participation in the Net-T test (EC10 spiral) and EC10. Each objective question is assigned a stop light color assessment as defined below:

Green	Objective fully satisfied – (G)
Green Yellow	Objective primarily satisfied – (GY)
Yellow	Objective partially satisfied – (Y)
Red	Objective not satisfied. – (R)
Blue.	No test. The conditions required for evaluating the objective did not occur – (B)

Objective JISRM-01. Employ Net-T/Vortex as the JBAIIC network and radio communications capability.

Objective Question JISRM-01.01. Was the JBAIIC CIP/CTP successfully passed via Net-T to the JTAC in the JRV? (G)

Net-T testing. The L-3 communications link was run UNCLASSIFIED and unencrypted. The JBAIIC CIP/CTP consisted of: TOC PPLI, ROVER PPLI (4), L-3 Cessna PPLI, and Cessna sensor SPOI. The CIP/CTP was successfully received and displayed on the CoT client in the JRV. The CIP/CTP was

also displayed on the GoBooks linked to each of the four ROVER 5s. Receipt of the CIP/CTP was constrained by the limited (approximately four mile) Vortex to ROVER range.

EC10 testing. The Net-T software was not used in EC10. The L-3 communications link was run SECRET (KSAF) and encrypted. The KSAF CIP/CTP (see Table 4) was successfully disseminated over the L-3 communications link to JRV clients, SNC T5s, and ROVER-linked GoBooks.

Objective Question JISRM-01.02. Was the JBAIIC CIP/CTP successfully passed via Vortex to the JTAC with a T5? (G)

EC10 testing. The KSAF CIP/CTP was successfully passed via the L-3 communications link from the TOC to the SNC T5.

Objective Question JISRM-01.03. Was FMV successfully passed via Net-T between the TOC and the JTAC in the JRV? (GY)

Net-T testing. Transcoded FMV from the RDAR in the TOC was successfully passed to ROVER (R2) via Net-T. The link was not reliable enough to allow the ROVER to request and retrieve FMV from the RDAR Archive.

EC10 testing. Transcoded FMV from: the Predator surrogate, BETSS-C, and Constant Hawk was successfully disseminated over the KSAF L-3 communications link to JRV clients and SNC T5s.

No attempt was made to send FMV from the field to the TOC.

Objective Question JISRM-01.04.Was FMV successfully passed via Vortex between the TOC to the JTAC with a T5? (G)

EC10 testing. Transcoded FMV from: the Predator surrogate, BETSS-C, and Constant Hawk was successfully disseminated over the KSAF L-3 communications link to the SNC T5s.

Objective Question JISRM-01.05. Was chat successfully passed via Net-T between the TOC and JRV? (G)

Net-T testing. Chat was successfully exchanged between the TOC and JRV using two TransVerse chat rooms (Ops and CoT) hosted on a NOC server. All chat was group chat rather than point-to-point. Chat was also successfully exchanged between the TOC and all four ROVERs and the Predator surrogate. Receipt of chat was constrained by the limited (approximately four miles) Vortex to ROVER range.

EC10 testing. Chat was passed over the L-3 Communication link between the TOC and JRV clients. Although capable of employing chat, the SNC T5 did not use chat in EC10.

Objective Question JISRM-01.06. Was VoIP successfully passed via Vortex between the TOC and the JTAC? (G)

Net-T testing. VoIP was successfully exchanged between the TOC and JRV using a call manager hosted on a NOC server. VoIP was also successfully exchanged between the TOC and all four ROVERs and the Predator surrogate. VoIP was also exchanged between ROVERs. Receipt of VoIP was constrained by the limited (approximately four miles) Vortex to ROVER range.

When connectivity existed, the quality of VoIP was generally good.

EC10 testing. TOC - JRV VoIP was not employed.

Objective Question JISRM-01.07. Was VoIP and FMV successfully simultaneously passed via Vortex between the TOC and the JTAC? (GY)

Net-T testing. There was only limited testing of transmission of FMV from the TOC to a ROVER and VoIP was not conducted simultaneously. There were numerous instances where VoIP was passed between the TOC and ROVERs, and the ROVERs simultaneously received FMV transmitted from the Vortex.

EC10 testing. TOC - JRV VoIP was not employed.

Objective Question JISRM-01.08. What is the throughput of Net-T using S band? (G)

Net-T uses S band for uplink from ROVER to Vortex. Throughput tests were conducted on July 22 and 23 and the results are summarized in the table below.

Table 8. Observed ROVER to Vortex (Uplink) Throughput

Date	ROVER	Average throughput (Kilobits/sec)	Number of observations averaged	Max throughput value (Kilobits/sec)
7/22	R1	2317	6	5478
7/22	R2	1695	8	3727
7/22	R4	873	3	1184
7/23	R1	1309	32	4560
7/23	R2	1258	6	2240
7/23	R4	751	36	1600

Note: *R3 performed poorly and is not included in the table. Few throughput measurements approached the maximum expected value of 4 megabits per second. It is likely that, at least for July 22, periods of non-connectivity were included in the reported values of throughput.*

Objective Question JISRM-01.09. What is the throughput of Net-T using Ku band? (B)

No test.

Objective Question JISRM-01.10. What is the maximum range between ROVER 5 and Vortex that allows reliable communications? (GY)

Net-T testing. During the experiment only one real time range measurement was made from the JRV. The range between the JRV and the L-3 aircraft was measured on the JRV CIP/CTP display when the link with the aircraft was lost. The range was observed to be six nautical miles. Since the JRV was equipped with the Ku band downlink antenna, this range would be greater than for a ROVER operating only on its internal antenna.

Objective JISRM-02. Create a JBAIIC CIP/CTP.

Objective Question JISRM-02.01. Were all appropriate inputs incorporated into the JBAIIC CIP/CTP? (GY)

Net-T testing. During the Net-T testing the CIP/CTP consisted of: TOC PPLI, ROVER PPLI (4), L-3 Cessna PPLI, MX-15iHD sensor SPOI.

EC10 testing. The JBAIIC NOC created and disseminated CIP/CTPs on each of the UCSN, KSAF, and CFE domains. The inputs observed in each of these domains are listed in Table 4. In principle, all CoT data were passed from lower to higher domains through the HSG. Generally it appeared to do this reliably. The most conspicuous failure in this regard was the inability to display UGS imagery passed from the UCSN to other domains.

Objective Question JISRM-02.02. Were Cortez NATO Friendly Force Information (NFFI) data translated to CoT? (B)

EC 10 testing. A NFFI to CoT translator was available in the JBAIIC NOC but Cortez NFFI data were not passed to the NOC. No test.

Objective JISRM-03. Integrate FBCB2 into the JBAIIC network

Objective Question JISRM-03.01. Were UAS asset SPOI successfully displayed on FBCB2 clients? (G)

Net-T testing. The L-3 Predator surrogate Cessna CoT PPLI and MX-15iHD SPOI messages were converted to VMF and sent to FBCB2 workstations in the TOC and JRV where the aircraft PPLI and sensor SPOI were displayed on the FBCB2 workstation.

EC10 testing. The FBCB2 clients in the JRV and TOC displayed the sensor PPLI, SPOI, and FOVs that were available in the KSAF CIP/CTP. These included: L-3 Predator surrogate, ScanEagle, and BETSS-C. These data were converted from CoT to VMF format in the NOC for display on FBCB2.

Objective Question JISRM-03.02. Were TACAIR SPOI successfully displayed on FBCB2 clients? (G)

EC10 testing. F-16C strike aircraft PPLI were displayed on the FBCB2 clients, but the aircraft did not send sensor/targeting pod SPOI. Accordingly, these data were not displayed in the CIP/CTP or FBCB2.

Objective Question JISRM-03.03. Was a subset of data from the JBAIIC CIP/CTP successfully displayed on the FBCB2 clients? (G)

Net-T testing. In addition to the Predator surrogate PPLI and SPOI, FBCB2 displayed the TOC and ROVER PPLI. For the Net-T testing the whole of the CIP/CTP was converted from CoT to VMF.

EC10 testing. The whole of the KSAF CIP/CTP was displayed on FBCB2.

Objective Question JISRM-03.04. Does the inclusion of SPOI in FBCB2 enhance its value to the warfighter? (B)

EC10 testing. The participants in operational roles used FV for their SA not FBCB2. No test.

Objective JISRM-04. Integrate RDAR with the JBAIIC TOC

Objective Question JISRM-04.01. Did the RDAR in the TOC successfully receive HD video? (G)

Net-T and EC10 testing. The RDAR successfully received HD FMV from the Predator surrogate MX-15iHD sensor via the L-3 GCS in the TOC.

Objective Question JISRM-04.02. Did the RDAR successfully transcode the HD video resolution for transmission to a disadvantaged user? (G)

Net-T testing. The RDAR successfully transcoded the HD video. The real time transcoded FMV was transmitted to, and received by ROVER (R2).

EC10 testing. The RDAR successfully transmitted transcoded HD MX-15iHD video to JRV clients and the SNC T5. In addition, it transmitted Constant Hawk and BETSS-C video to these same JRV nodes.

Objective Question JISRM-04.03. Was the RDAR able to simultaneously receive FMV and search its repository? (G)

Net-T testing. Yes

Objective Question JISRM-04.04. Was the RDAR able to simultaneously receive FMV and disseminate archived FMV to a tactical user? (G)

Net-T testing. The RDAR received the Predator surrogate HD FMV and simultaneously transmitted transcoded video to ROVER (R2).

EC10 testing. The RDAR received the Predator surrogate HD FMV and simultaneously transmitted transcoded video to the JRV client and Tacticomp T5.

Objective Question JISRM-04.05. Did the RDAR demonstrate STANAG 4559 functionality? (B)

Net-T testing. No appropriate system was available for this test. No test.

EC10 testing. No appropriate system made itself available for this test. No test.

Objective ISRS-01. Execute digital CAS missions using L-3 communications capability

Objective Question ISRS-01.01. Were JRV digital CAS missions communicated via the L-3 communications capability received and acknowledged by the strike aircraft? (Y)

EC10 testing. DCAS messages were generated by the KSAF JRV client and the KSAF Tacticomp T5 on the JRV client and passed by the L-3 communications link to the NOC where they were translated into J message formats for transmission, via the JRE, to strike aircraft. The strike aircraft acknowledged receipt of these messages.

The BAO Kit on the JRV client and the SNC T5 Tacticomp developed a nine-line message for the strike aircraft. But the only information the strike aircraft received was a J3.5 or J12. The aircraft did not receive the full data contained in the original BAO Kit-generated nine-line message, nor the significantly more robust information inherent in a voice nine-line brief.

The JRV CFE client and the CFE Tacticomp T5 also produced nine-lines, passed to the NOC via the PRC-117G, which produced J3.5 or J12 messages that were received and acknowledged by the strike aircraft.

Objective Question ISRS-01.02. Were JBAIIC nodes able to successfully control the L-3 aircraft MX-15iHD sensor? (B)

Net-T and EC10 testing. The necessary control software was not loaded on any JBAIIC node. The only node that could remotely control the MX-15iHD sensor was the L-3 GCS in the NOC. No test.

Objective ISRS-2.0. Integrate TACP CASS and JBAIIC digital CAS operations

Objective Question ISRS-02.01. Was the JRV CoT client CIP/CTP successfully integrated with TACP-CASS? (G)

EC10 testing. TACP CASS was loaded on the JRV CFE and KSAF clients. The original intent was for TACP CASS to generate CoT nine-line messages for transmission to the strike aircraft. But the version of TACP CASS available for EC10 was not capable of generating CoT nine-lines. As a result, the CoT nine-lines had to be produced by the BAO Kit application that was loaded on the same clients. In some missions, TACP CASS generated the target that automatically populated the target information in the nine-line message developed in BAO Kit. The integration of TACP-CASS with the JRV clients was as complete as possible given the constraints.

Objective Question ISRS-02.02. Was the Tacticomp T5 CIP/CTP successfully integrated with TACP-CASS? (B)

EC10 testing. TACP CASS was not loaded on the Tacticomp T5. No test.

Objective Question ISRS-02.03. Was a ruggedized computer CIP/CTP connected to ROVER 5 successfully integrated with TACP-CASS? (B)

EC10 testing. TACP CASS was not loaded on the GoBooks. No test.

Objective Question ISRS-02.04. Were JRV TACP CASS-generated LOS CAS communications received and acknowledged by the strike aircraft? (B)

EC10 testing. TACP CASS could not generate CoT nine-lines so no TACP CASS messages were sent to, received, or acknowledged by strike aircraft. No test.

Objective Question ISRS-02.05. Were JRV TACP CASS-generated BLOS CAS communications received and acknowledged by the strike aircraft? (B)

EC10 testing. TACP CASS could not generate CoT nine-lines so no TACP CASS messages were sent to, received, or acknowledged by strike aircraft. No test.

Objective Question ISRS-02.05. Does the JBAIIC CIP/CTP enhance the capability of the JTAC using TACP-CASS? (G)

EC10 testing. BAO Kit rather than TACP CASS was used to develop the strike missions . No test for TACP CASS.

The JTAC found the CIP/CTP provided significant battlespace awareness in executing DCAS missions. In particular, the location of friendly forces, and the presentation of the nine-line mission on the display providing confirmation of his intent. When the CFE CIP/CTP was used, the PPLI of the strike aircraft was also available, which provided additional important situational awareness.

Objective ISRS-03. Employ SNC devices in execution of digital CAS

Objective Question ISRS-03.01. Were Tacticomp T5-equipped, JTAC-generated LOS CAS communications received and acknowledged by the strike aircraft? (B)

EC10 testing. No DCAS missions were conducted LOS in EC10. All aircraft communications were through the JRE and SADL/Link-16. No test.

Objective Question ISRS-03.01. Were Tacticomp T5-equipped, JTAC-generated BLOS CAS communications received and acknowledged by the strike aircraft? (G)

EC10 testing. Tacticomp T5-generated nine-line messages on both CFE and KSAF. These nine-lines resulted in the generation of J3.5 and J12 messages which were received and acknowledged by the F-16C strike aircraft.

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Appendix 1

Net-T Test Plan for July 23

Version 1: 23 July 2010

1. 0600 – Daily pre-experiment set-up activities
2. 0630 -- Mission Brief-TOC
3. 0715 -- Muster reports due to BN CDR
4. 0715 – Predator surrogate launch.
5. 0730 -- Muster reports due to EC10 Staff.
6. 0730 -- Predator surrogate on station
7. 0715 – JRV, JBAIIC Dodge Truck, and trail vehicle #3 power up at JBAIIC Compound with four ROVER 5s:
    a. ROVER 1- JBAIIC Dodge Truck
    b. ROVER 2-trail vehicle #3
    c. ROVER 3-trail vehicle #3
    d. ROVER 4-JRV
8. 0715 -- Connectivity/Comm Checks:
    a. UHF Comm check:
        i. BN CDR & JRV (JBAIIC Channel 1, 235,175), upon completion, switch to ATC 374.1, JBAIIC Channel-4)
    b. Vortex (Predator surrogate) to GCS (L-3com TOC) connectivity check.
    c. UHF Comm check (374.1, JBAIIC Channel-4):
        i. BN CDR & Predator surrogate
        ii. BN CDR & JBAIIC Dodge Truck
    d. Net-T VoIP check. Position/call sign/VOIP #/location
        i. Predator surrogate (Firebird) 1006 (Cessna)
        ii. BN Cdr (Rock Steady) 1007 (TOC)
        iii. ROVER 1 1001 (JBAIIC Dodge Truck)
        iv. ROVER 2 1002 (trail vehicle #3)
        v. ROVER 3 1003 (trail vehicle #3)
        vi. ROVER 4 (Killer) 1004 (JRV)
        vii. STE (L-3Com GCS) 1005 (TOC)
        viii. Data Collection 1008 (TOC)
    e. Net-T chat checks.
        i. Predator surrogate (Firebird) (Cessna)
        ii. BN Cdr (Rock Steady) (TOC)
        iii. ROVER 1 (JBAIIC Dodge Truck)
        iv. ROVER 2 (trail vehicle #3)
        v. ROVER 3 (trail vehicle #3)
        vi. ROVER 4 (Killer) (JRV)

vii. STE (L-3Com GCS) (TOC)
viii. Data Collection (TOC)
ix. S6 (Paul) (TOC)

f. I-CIP/CTP checks.
   i. Predator surrogate (Firebird) (Cessna)
   ii. BN Cdr (Rock Steady) (TOC)
   iii. ROVER 1 (JBAIIC Dodge Truck)
   iv. ROVER 2 (trail vehicle #3)
   v. ROVER 3 (trail vehicle #3)
   vi. ROVER 4 (Killer) (JRV)
   vii. STE (L-3Com GCS) (TOC)
   viii. S6 (TOC)

g. Cell Phone checks w/ TOC (520-538-7192/0)
   i. ROVER 1 (JBAIIC Dodge Truck)
   ii. ROVER 2 (trail vehicle #3)
   iii. ROVER 3 (trail vehicle #3)
   iv. ROVER 4 (Killer) (JRV)

9. 0730 (or upon completion of connectivity checks) – JRV, JBAIIC Dodge Truck, and trail vehicle #3 depart with four ROVER 5s:
   ROVER 1- JBAIIC Dodge Truck
   ROVER 2-trail vehicle #3
   ROVER 3-trail vehicle #3
   ROVER 4-JRV
10. 0745: PM UAS RDAR begins to receive video from the MX15iHD on the Predator surrogate. Any changes to the video stream from the Predator surrogate will be coordinated through the BN CDR for Net-T GCS action.
11. 0745: BN S6 ensures that the JBAIIC I-CIP/CTP is displaying ROVER 5 tracks, JRV tracks, and Predator surrogate tracks as well as the SPOI tracks from the Predator surrogate MX15iHD sensor.
12. 0745 -- Vehicles arrive on station. ROVERs remain on vehicle power.
13. 0745 - 0815 -- Connectivity Checks:
    a. UHF Comm check (374.1, JBAIIC Channel-4):
       i. BN CDR & Predator surrogate
       ii. BN CDR & JBAIIC Dodge Truck
    b. Net-T VoIP check. Position/call sign/VOIP #/location
       i. Predator surrogate (Firebird) 1006 (Cessna)
       ii. BN Cdr (Rock Steady) 1007 (TOC)
       iii. ROVER 1 1001 (JBAIIC Dodge Truck)
       iv. ROVER 2 1002 (trail vehicle #3)
       v. ROVER 3 1003 (trail vehicle #3)
       vi. ROVER 4 (Killer) 1004 (JRV)
       vii. STE (L-3Com GCS) 1005 (TOC)
       viii. Data Collection 1008 (TOC)
    c. Net-T chat checks.
       i. Predator surrogate (Firebird) (Cessna)
       ii. BN Cdr (Rock Steady) (TOC)
       iii. ROVER 1 (JBAIIC Dodge Truck)

        iv. ROVER 2 (trail vehicle #3)
        v. ROVER 3 (trail vehicle #3)
        vi. ROVER 4 (Killer) (JRV)
        vii. STE (L-3Com GCS) (TOC)
        viii. Data Collection (TOC)
        ix. S6 (TOC)
    d. I-CIP/CTP checks.
        i. Predator surrogate (Firebird) (Cessna)
        ii. BN Cdr (Rock Steady) (TOC)
        iii. ROVER 1 (JBAIIC Dodge Truck)
        iv. ROVER 2 (trail vehicle #3)
        v. ROVER 3 (trail vehicle #3)
        vi. ROVER 4 (Killer) (JRV)
        vii. STE (L-3Com GCS) (TOC)
        viii. S6 (TOC)
    e. Video Reception from Predator surrogate (Firebird) (Cessna)
        i. BN Cdr (Rock Steady) (TOC)
        ii. ROVER 1 (JBAIIC Dodge Truck)
        iii. ROVER 2 (trail vehicle #3)
        iv. ROVER 3 (trail vehicle #3)
        v. ROVER 4 (Killer) (JRV)

14. 0800 – 1100: JTAC will generate UNCLASSIFIED strike coordinates using the JBAIIC I-CIP/CTP and the TACP-CAS suite. The JTAC will send a strike nine-line message to the BN CDR via the Net-T architecture. Make multiple attempts.
15. 0800: The JTAC in the JRV will use the ROVER 5 to gain access to the RDAR portal to test the ability to receive real-time and archived video from the RDAR. Coordination between the JTAC and RDAR personnel will be done both on site with an accompanying RDAR representative and via the Net-T VoIP and chat with RDAR personnel in the BN TOC.
16. 0900 - 1030: Throughput checks from each of the ROVERs. Each check will take approximately 16 minutes or two orbits of the Predator surrogate. We will have all four ROVERs up for the first period and then drop one off each time period. Impact of each ROVER departing and returning to the Net-T System will be noted.
17. 1030: Upon completion of the throughput testing, ROVERs 1, 2, & 3 will disconnect from vehicle power and operate via battery. ROVER 2 and 3 will move to new locations (via trail vehicle #3) for first range check. Locations TBD by BN CDR and Data Collections. ***NOTE-ROVERs have 80 minute maximum operational time on battery power. ***
18. 1030 - 1100 -- Connectivity Checks:
    a. UHF Communications check (374.1, JBAIIC Channel-4):
        i. BN CDR & Predator surrogate
        ii. BN CDR & JBAIIC Dodge Truck
    b. Net-T VoIP check. Position/call sign/VOIP #/location
        i. Predator surrogate (Firebird) 1006 (Cessna)
        ii. BN Cdr (Rock Steady) 1007 (TOC)
        iii. ROVER 1 1001 (JBAIIC Dodge Truck)
        iv. ROVER 2 1002 (trail vehicle #3)
        v. ROVER 3 1003 (trail vehicle #3)

    vi. ROVER 4 (Killer) 1004 (JRV)
    vii. STE (L-3Com GCS) 1005 (TOC)
    viii. Data Collection 1008 (TOC)
 c. Net-T chat checks as well.
    i. Predator surrogate (Firebird) (Cessna)
    ii. BN Cdr (Rock Steady) (TOC)
    iii. ROVER 1 (JBAIIC Dodge Truck)
    iv. ROVER 2 (trail vehicle #3)
    v. ROVER 3 (trail vehicle #3)
    vi. ROVER 4 (Killer) (JRV)
    vii. STE (L-3Com GCS) (TOC)
    viii. Data Collection (TOC)
    ix. S6 (Paul) (TOC)
 d. I-CIP/CTP checks.
    i. Predator surrogate (Firebird) (Cessna)
    ii. BN Cdr (Rock Steady) (TOC)
    iii. ROVER 1 (JBAIIC Dodge Truck)
    iv. ROVER 2 (trail vehicle #3)
    v. ROVER 3 (trail vehicle #3)
    vi. ROVER 4 (Killer) (JRV)
    vii. STE (L-3Com GCS) (TOC)
    viii. S6 (Paul) (TOC)
 e. Video Reception from Predator surrogate (Firebird) (Cessna)
    i. BN Cdr (Rock Steady) (TOC)
    ii. ROVER 1 (JBAIIC Dodge Truck)
    iii. ROVER 2 (trail vehicle #3)
    iv. ROVER 3 (trail vehicle #3)
    v. ROVER 4 (Killer) (JRV)

19. 1040: The two dismounted ROVER 5s re-enter the network at new location with VoIP check, chat check, and video reception checks. Impact of the two ROVER 5s entering the Net-T system noted.
20. 1100 -- The two dismounted ROVER 5s reposition (via trail vehicle) to new position (TBD by BN CDR and Data Collections) while remaining in the Net-T network. Once established at the new position, test video reception, VoIP, and chat.
 a. UHF Comm check (374.1, JBAIIC Channel-4):
    i. BN CDR & Predator surrogate
    ii. BN CDR & JBAIIC Truck
 b. Net-T VoIP check. Position/call sign/VOIP #/location
    i. Predator surrogate (Firebird) 1006 (Cessna)
    ii. BN Cdr (Rock Steady) 1007 (TOC)
    iii. ROVER 1 1001 (JBAIIC Dodge Truck)
    iv. ROVER 2 1002 (trail vehicle #3)
    v. ROVER 3 1003 (trail vehicle #3)
    vi. ROVER 4 (Killer) 1004 (JRV)
    vii. STE (L-3Com GCS) 1005 (TOC)
    viii. Data Collection 1008 (TOC)
 c. Net-T chat checks as well.

        i. Predator surrogate (Firebird) (Cessna)
        ii. BN Cdr (Rock Steady) (TOC)
        iii. ROVER 1 (JBAIIC Dodge Truck)
        iv. ROVER 2 (trail vehicle #3)
        v. ROVER 3 (trail vehicle #3)
        vi. ROVER 4 (Killer) (JRV)
        vii. STE (L-3Com GCS) (TOC)
        viii. Data Collection (TOC)
        ix. S6 (Paul) (TOC)
    d. I-CIP/CTP checks.
        i. Predator surrogate (Firebird) (Cessna)
        ii. BN Cdr (Rock Steady) (TOC)
        iii. ROVER 1 (JBAIIC Dodge Truck)
        iv. ROVER 2 (trail vehicle #3)
        v. ROVER 3 (trail vehicle #3)
        vi. ROVER 4 (Killer) (JRV)
        vii. STE (L-3Com GCS) (TOC)
        viii. S6 (Paul) (TOC)
    e. Video Reception from Predator surrogate (Firebird) (Cessna)
        i. BN Cdr (Rock Steady) (TOC)
        ii. ROVER 1 (JBAIIC Dodge Truck)
        iii. ROVER 2 (trail vehicle #3)
        iv. ROVER 3 (trail vehicle #3)
        v. ROVER 4 (Killer) (JRV)

21. 1115 – Predator surrogate and JRV, JBAIIC Dodge Truck, and trail vehicle #3 RTB.
22. 1115 -- Predator surrogate lands.
23. 1200-1500 – Remove the Net-T firmware from the Vortex, Mini-T, and ROVER 5s and replace with the latest firmware for the same hardware. Install the KGV135A chipsets, load keys, and test.
24. 1245 -- Debrief in JBAIIC compound.

1500 -- End of Day report due to EC10 Leadership/Admin

Appendix 2

ROVER Throughput Data from July 22

Time (Local)	collection interval (sec)	Kbytes/sec	Kbits/sec	ROVER	Comments
	188	555	4440	1	**R1 only operating**
9:53			0		Turn off video
	76.86	150.35	1202.8	1	
	188.22	684.80	5478.4	1	
			0		**R1 and R2 operating**
	9.14	465.94	3727.52	2	
10:10			0		Shut down RDAR
	134.42	150.33	1202.64	2	
	104.09	234.81	1878.48	2	
10:20	94.83	126.58	1012.64	2	
10:22	317.28	153.44	1227.52	1	
10:30			0		**R1, R2, R3, R4 operating**
10:30	250.84	40.08	320.64	1	
10:31	92.72	314	2512	2	
10:31	317.28	153.99	1231.92	1	
10:43	113.91	72.8	582.4	2	
10:46	193.14	6.43	51.44	3	Poor connectivity
10:51	33.42	258.64	2069.12	2	
10:52	49.75	6.26	50.08	3	Poor connectivity
10:53	52.81	71.91	575.28	2	
10:54	40.75	25.63	205.04	3	
10:55		137	1096	4	
11:09		42.42	339.36	4	
11:12		148	1184	4	

Appendix 3

ROVER Throughput Data from July23

Time GMT hhmmss	Kbytes/sec	Kbits/sec	ROVER
1607	180	1440	4
160730	98	784	4
1608	28	224	4
160830	9	72	4
1611	68	544	4
161130	85	680	4
1612	110	880	4
161230	150	1200	4
1613	24	192	4
161330	11	88	4
1614	5	40	4
1616	1	8	4
1619	113	904	4
161930	47	376	4
1620	90	720	4
162030	45	360	4
1621	135	1080	4
1622	33	264	4
162230	83	664	4
1623	45	360	4
162330	36	288	4
1626	195	1560	4
162630	120	960	4
1627	107	856	4
162730	103	824	4
1628	119	952	4
162830	150	1200	4
162930	40	320	4
1630	138	1104	4
163030	35	280	4
1631	32	256	4
1633	90	720	4
1634	200	1600	4
163430	170	1360	4
1635	170	1360	4
163530	30	240	4
1616	172	1376	2

1620	280	2240	2
1622	218	1744	2
162230	0.7	5.6	2
162320	189	1512	2
162350	84	672	2
1603	299	2392	1
160330	75	600	1
1608	100	800	1
1611	100	800	1
161130	267	2136	1
1615	5	40	1
161530	231	1848	1
1616	100	800	1
161730	130	1040	1
1618	354	2832	1
1619	0.5	4	1
1620	43	344	1
162030	44	352	1
162230	73	584	1
1623	22	176	1
162430	324	2592	1
1625	45	360	1
162530	187	1496	1
1626	46	368	1
162630	21	168	1
1627	10	80	1
162730	176	1408	1
1628	70	560	1
162830	47	376	1
1629	50	400	1
162930	8	64	1
163030	273	2184	1
1631	240	1920	1
163130	460	3680	1
1632	540	4320	1
163230	325	2600	1
1633	570	4560	1

Appendix 4

Strike Aircraft Mission Schedule for EC10

August	2	3	4	5	6
AM	CAS	Strike	CAS	CAS	Strike
PM	Strike	CAS	Strike/EPLRS	Strike/EPLRS	CAS

August	9	10	11	12	13
AM	CAS	Strike	EPLRS/CAS	Strike	CAS
PM	Strike	EPLRS/CAS	CAS	CAS	Strike

Appendix 5

PRC-117G and PRC-117F Radio Range Testing

PRC-117G

Operationally the TOC to JRV communications link via the PRC-117G radio was of critical importance. Several tests were conducted to determine the maximum effective range of communications.

Test parameters:

- PRC-117 G TOC discone antenna was mounted on the roof of the ISIL at 39 feet AGL.
- Waveform used Harris Adaptive Networking Wideband Waveform (ANW 2).
- Power 50 watts.
- PRC-117G in TOC was configured for data only.
- PRC-117G in the JRV had a Harris 12006-5222-01 (30-450 MHZ) antenna. The top of the antenna was 10 feet AGL

On August 6 the maximum range achieved on Fort Huachuca east range was 8.1 miles (in the vicinity of British FOB Delhi)

A second test was conducted late in the afternoon of August 6 in heavy rain. The comms link was effective to a range of 17 miles in the vicinity of the intersection of route 90 and route 80. Mountains in that area were the likely cause of the loss of link rather than the distance. Elevation at loss of signal was 4,747 feet. The elevation at the TOC was 4,757 feet.

PRC-117F

- Waveform used: Amplitude Modulation (AM).
- Power 10 watts.
- Height of PRC-117F TOC antenna is 28 feet 6 inches.
- Height of the top of the JRV PRC-117F antenna was approximately seven feet AGL.
- Max range approximately eight miles.

Appendix 6

Glossary

AM	Ante Meridian
AM	Amplitude Modulation
ANW2	Advanced/Adaptive Networking Wideband Waveform
AOCO	Airborne Overhead Cooperative Operations
AOIO	Airborne Overhead Interoperability Office
ARL	Army Research Laboratory
ATE	Air Terminal Equipment
AWACS	Airborne Warning and Control System
BAO Kit	Battlefield Air Operations Kit
BETSS-C	Base Expeditionary Targeting and Surveillance Systems - Combined
BFT	Blue Force Tracking
BN	Battalion
CAS	Close Air Support
CDCIE	Domain Collaborative Information Environment
CDR	Commander
CFE	Coalition Four Eyes
CIP	Common Intelligence Picture
CoT	Cursor-on-Target
CTP	Common Tactical Picture
RDAR	Data Archive and Retrieval
DCAS	Digitally-aided Close Air Support
DCGS-A	Distributed Common Ground System - Army

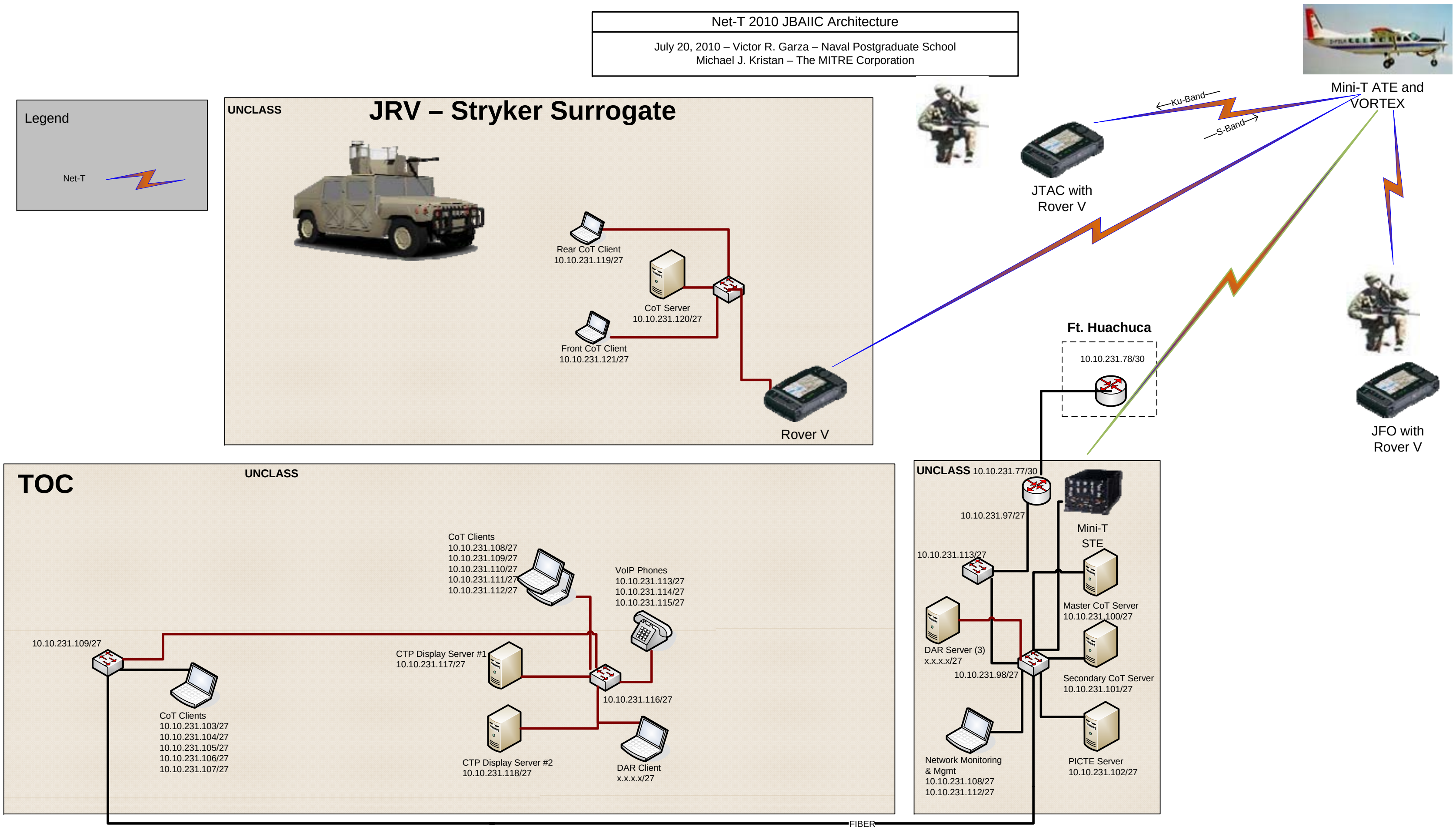
DTRA	Defense Threat Reduction Agency
ELINT	Electronic Intelligence
E/O	Electro-Optical
EPLRS	Enhanced Position Location Reporting System
FBCB2	Force XXI Battle Command Brigade and Below
FMV	Full Motion Video
FOB	Forward Operating Base
FTP	File Transfer Protocol
FV	FalconView
GCS	Ground Control Station
GMTI	Ground Moving Target Indicator
HAF/A2Q	Headquarters Air Force Intelligence, Surveillance, and Reconnaissance Innovation Division
HD	High Definition
HSG	High Speed Guard
IP	Initial Point
IP	Internet Protocol
IR	Infrared
ISR	Intelligence, Surveillance, and Reconnaissance
ISIL	Intelligence Systems Integration Laboratory
JBAIIC	Joint Battlespace Awareness Intelligence, Surveillance and Reconnaissance Integration Capability
JFO	Joint Forward Observer
JIL	Joint Intelligence Laboratory
JISRM	Joint Intelligence Surveillance and Reconnaissance Management
JMSM	Joint Mission Support Module

JRE	Joint Range Extension
JSTARS	Joint Surveillance Target Attack Radar System
JTAC	Joint Terminal Attack Controller
JRV	Joint Reconfigurable Vehicle
KLV	Key Length Value
KSAF	Kalochistan Security Assistance Force
LMRS	Land Mobile Radio System
LNO	Liaison Officer
MSL	Mean Sea Level
MTCD	Multi TADIL Converter Daemon
NATO	North Atlantic Treaty Organization
NFFI	NATO Friendly Force Information
NITF	National Imagery Transmission Format
NOC	Network Operations Center
NRO	National Reconnaissance Office
PGSS	Persistent Ground Surveillance Systems
PM	Post Meridian
PPLI	Precise Participant Location and Identification
RDAR	Rack-mounted Data Archive and Retrieval
ROVER	Remotely Operated Video Enhanced Receiver
RWR	Radar Warning Receiver
SA	Situational Awareness
SADL	Situation Awareness Data Link
SNC	Sierra Nevada Corporation
SPOI	Sensor Point of Interest

STANAG	Standardization Agreement
STE	Surface Terminal Equipment
TACP CASS	Tactical Air Control Party Close Air Support System
Tacticomp	Tactical Computer
TCDL	Tactical Common Data Link
TDVR	Tactical Digital Video Recorder
TOC	Tactical Operations Center
TPG	Target Package Generator
UAS	Unmanned Aerial System
UCSN	Unclassified Common Sensor Network
UGS	Unattended Ground Sensor
UHF	Ultra High Frequency
UTM	Universal Transverse Mercator
VAP	Versatile Access Point
VMF	Variable Message Format
VoIP	Voice over Internet Protocol

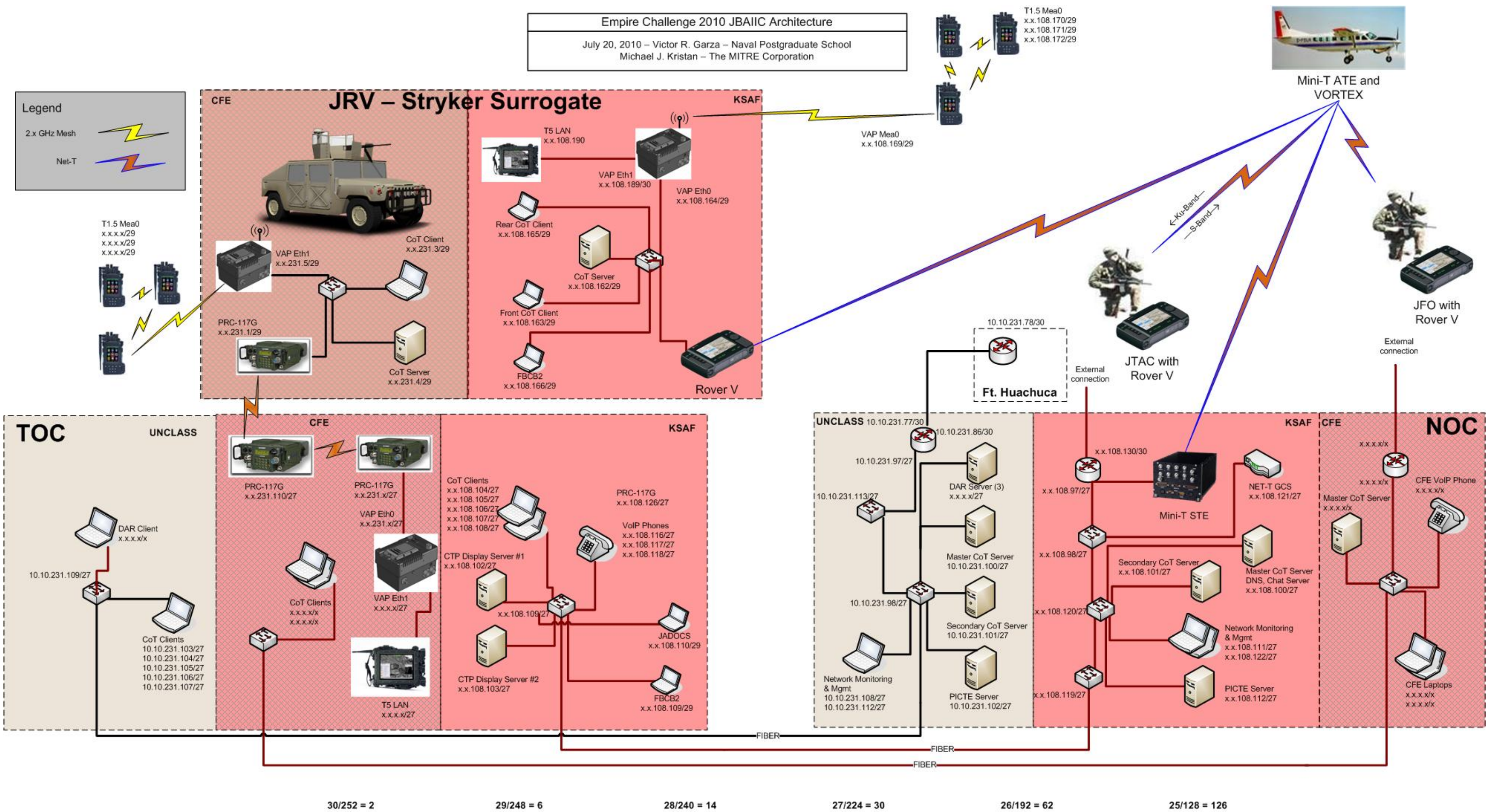
Appendix 7

Network Architecture for Net-T Testing



Appendix 8

JBAIIC Network Architecture in EC10



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